Canadian Mathematical Society
Société mathématique du Canada

CMS 75+1 Anniversary SUMMER MEETING

RÉUNION D'ÉTÉ du 75+1 anniversaire DE LA SMC

JUNE 5-8 JUIN, 2020 | OTTAWA, ON

Plenary Lectures | Conférences plénières

Henri Darmon (McGill)
Moon Duchin (Tufts)
Matilde Marcolli (Toronto)
Aaron Naber (Northwestern)
Ian Putnam (Victoria)

Public Lecture | Conférence publique

Anne Broadbent (Ottawa)

Prizes | Prix

Excellence in Teaching Award | Prix d'excellence en enseignement
Joseph Khoury (Ottawa)
Jeffery-Williams Prize | Prix Jeffery-Williams
Juncheng Wei (UBC)
Krieger-Nelson Prize | Prix Krieger-Nelson
Sujatha Ramdorai (UBC)

Scientific Directors | Directrices scientifiques

Ailana Fraser (UBC)
Monica Nevins (Ottawa)
Mateja Šajna (Ottawa)

Scientific Organizing Committee | Comité scientifique

Benoît Collins (Kyoto)
Anita Layton (Waterloo)
Kathryn Mann (Cornell)
Robert McCann (Toronto)
Ram Murty (Queen's)

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Schedule / horaire

CMS Summer Meeting 2021- ONLINE MEETING-All Times are Eastern Time

Friday Vendredi		Monday Lundi	Tuesday Mardi	Wednesday Mecredi	Thursday Jeudi	Friday Vendredi
June 4 juin		June 7 juin	June 8 juin	June 9 juin	June 10 juin	June 11 juin
11 :00-12:00 CMS Dev. Group Meeting | Réunion du Groupe de dév. SMC	11:00-14:00 CMS Mini-Courses | Mini-cours de la SMC	10:45-11:00 Opening and Welcome | Ouverture et bienvenue	10:00-11:00 Scientific Sessions scientifiques	10:00-11:00 Scientific Sessions scientifiques	10:00-11:00 Scientific Sessions scientifiques	10:00-11:00 Scientific Sessions scientifiques
		11:00-12:00 Ian Putman Plenary Lecture | Conférence plénière	11:00-12:00 Aaron Naber Plenary Lecture | Conférence plénière	11:00-12:00 Moon Duchin Plenary Lecture | Conférence plénière	11:00-12:00 Matilde Marcolli Plenary Lecture | Conférence plénière	11:00-12:00 Henri Darmon Plenary Lecture | Conférence plénière
12:00-12:30 **Break | Pause** *Online Lounge*		12:00-12:30 **Break | Pause** *Online Lounge*	12:00-12:30 **Break | Pause** *Online Lounge*	12:00-12:30 **Break | Pause** *Online Lounge*	12:00-12:30 **Break | Pause** *Online Lounge*	12:00-12:30 **Break | Pause** *Online Lounge*
12:30-17:30 CMS Board of Directors Meeting | Réunion du Conseil d'administration SMC	14:00-15:00 **Break | Pause**	12:30-14:00 Scientific Sessions scientifiques	12:30-14:30 Scientific Sessions scientifiques	12:30-14:30 Scientific Sessions scientifiques	12:30-14:30 Scientific Sessions scientifiques	12:30-14:00 Scientific Sessions scientifiques
	15:00-18:00 CMS Mini-Courses | Mini-cours de la SMC	14 :00-16:00 CMS-CMESG Joint Panel | Table-ronde SMC-CMSESG	14:30-15:00 **Break | Pause** *Online Lounge*	14:30-15:00 **Break | Pause** *Online Lounge*	14:30-15:00 **Break | Pause** *Online Lounge*	14:00-15:00 CMS AGM | L'AGA de la SMC
			15:00-16:00 Joel Kamnitzer Jeffery-Williams Prize Lecture | Conférence de prix Jeffery-Williams	15 :00-16:00 Panel Excellence in Teaching Award Lecture | Conférence de prix d'excellence en enseignement	15:00-16:00 Anita Layton Krieger-Nelson Prize Lecture | Conférence de prix Krieger-Nelson	15:00-16:30 Scientific Sessions scientifiques
		16:00-17:30 Scientific Sessions scientifiques	16:00-18:00 Scientific Sessions scientifiques	16:00-17:00 Scientific Sessions scientifiques	16:00-18:00 Scientific Sessions scientifiques	16:30-17:00 Closing Ceremony
		18:00-20:30 Student Social | Soirée étudiante		17:00-18:00 Anne Broadbent Public Lecture | Conférence publique		

Notes

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- Up to 50% off publications
- Includes CMS newsletter: *CMS Notes*

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Visit our virtual CMS booth for more information or leave a message in the chat.

Devenez un nouveau membre aujourd'hui !

Saviez-vous que l'adhésion à la SMC offre plusieurs avantages, notamment des réductions?

- Les départements de mathématiques peuvent parrainer l'adhésion de leurs étudiants
- Les frais sont une dépense admissible pour les Subventions à la découverte du CRSNG
- Réductions sur les frais d'inscription aux Réunions de la SMC
- Économies substantielles pour les résidents canadiens qui souhaitent également se joindre à d'autres sociétés ayant un accord de réciprocité avec la SMC – AMS, MAA, etc.
- Jusqu'à 50 % de réduction sur les publications
- Abonnement inclus à notre bulletin, les *Notes de la SMC*

Saviez-vous que la SMC offrait l'adhésion à deux ans pour un an aux nouveaux membres? Adhérez dès aujourd'hui!

Veuillez visiter le kiosque virtuel de la SMC pour plus d'informations ou laissez un message dans le chat.

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Welcome to the 2021 CMS Summer Meeting!

On behalf of the Canadian Mathematical Society, it is my great pleasure to welcome you to the 2021 CMS Online Summer Meeting. This conference, hosted virtually, will cover a wide variety of topics reflecting the scope and diversity of the Canadian mathematical sciences community. Despite the pandemic, the turnout is remarkable and there will be tremendous opportunities for collaborations and renewal of contacts with colleagues from Canada and around the world. The CMS profoundly thanks its members and allies for their constant support and dedication.

A year ago, when we postponed the 2020 Summer Meeting, we all were expecting to all meet in Ottawa with the pandemic behind us in 2021. That wish has not quite come through and we meet once again online. But during this past year and through all the challenges and adversity our community has faced, we have continued to meet, research, and grow. So while we won't be in each other's presence at the beautiful University of

Bienvenue à la Réunion d'été 2021 de la SMC!

Au nom de la Société mathématique du Canada, j'ai le grand plaisir de vous accueillir à la Réunion virtuelle d'été 2021 de la SMC. Cet évènement contient des discussions sur une grande variété de sujets mathématiques, reflétant la portée et la diversité de la communauté mathématique du Canada. Malgré les restrictions imposées par la pandémie hygiénique, le taux d'inscription est impressionnant. Les participant.e.s y trouveront de nombreuses occasions de collaborer et de renouer le contact avec des collègues du Canada et du monde entier. La SMC tient à remercier ses membres et ses allié.e.s pour leur soutien et leur dévouement continus.

Il y a un an, nous avons pris la décision difficile de reporter la Réunion d'été 2020, envisageant nous rassembler de nouveau en été 2021, libres de la pandémie. Cela ne s'est pas tout à fait réalisé et nous devons nous unir, encore une fois, en ligne. Cela dit, notre communauté a continué ses activités malgré des défis et des difficultés. Bien que nous nous désolions de ne pas pouvoir profiter de la présence de nos collègues sur le beau campus de l'Université d'Ottawa, nous sommes néanmoins ravis d'avoir la chance de nous unir virtuellement et de collaborer et de partager nos savoirs.

Ottawa Campus, we are delighted to have the chance to keep in touch, collaborate and share our knowledge.

The meeting program features five plenary lectures, by Henri Darmon (McGill University), Moon Duchin (TUFTS University), Matilde Marcolli (University of Toronto), Aaron Naber (Northwestern University) and Ian Putnam (University of Victoria).

The Summer Meeting's program features over 40 sessions and 8 mini courses with talks relating to all aspects of mathematical sciences, and a scientific session organized and delivered entirely by graduate and undergraduate students. The meeting will also include a forum by our new Equity, Diversity and Inclusiveness Committee. The CMS has also partnered with CMESG for an education panel.

The meeting will also provide further opportunities for celebrating excellence in mathematics by honouring the recipients of the Excellence in Teaching Award, Alfonso Gracia-Saz (University of Toronto), the Jeffrey-Williams Prize, Joel Kamnitzer (University of Toronto), the Krieger-Nelson Prize, Anita Layton (University of Waterloo). All prizes will be recognized at the opening ceremony on Monday, June 7, 2021 on the meeting platform.

On behalf of the CMS, I would like to express the gratitude of the CMS to all the sponsors of the Summer Meeting: University of Ottawa, Bolster Academy, Maple, AARMS, CRM, Fields, PIMS.

Ailana Fraser (University of British Columbia), Monica Nevins (University of Ottawa) and Mateja Šajna (University of Ottawa), the Scientific Directors, have put a tremendous amount of hard work into bringing you an attractive and varied program and greatly deserve our thanks. Putting on such a meeting requires much dedication and hard work and would not be possible without the efforts of the scientific directors, the session organizers, and the CMS staff.

Finally, to all participants, I would like to wish you a very productive and pleasurable meeting. Welcome to our second online meeting!

Javad Mashreghi
President, CMS

Le programme de la Réunion comprend cinq conférences plénières, présentées par Henri Darmon (McGill University), Moon Duchin (TUFTS University), Matilde Marcolli (University of Toronto), Aaron Naber (Northwestern University) et Ian Putnam (University of Victoria).

Le programme de la Réunion d'été compte aussi plus de 40 sessions et 8 mini-cours avec des communications portant sur tous les aspects des sciences mathématiques et une session organisées entièrement par et pour les étudiant.e.s du premier, deuxième et troisième cycles. Le Comité d'équité, de la diversité et de l'inclusivité a aussi organisé un forum le cadre de la Réunion. La SMC tient encore une fois une séance conjointe avec le GCEDM sur l'éducation.

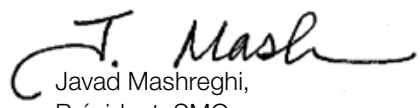
La Réunion d'été de la SMC est aussi une occasion de célébrer l'excellence en mathématiques en honorant les lauréats des prix de la SMC : le feu Alfonso Gracia-Saz (University of Toronto), lauréat du Prix d'excellence en enseignement; Joel Kamnitzer (University of Toronto), lauréat du Prix Jeffrey-Williams; et Anita Layton (University of Waterloo), lauréate du prix Krieger-Nelson. Ceux-ci seront reconnus lors de la cérémonie d'ouverture le lundi 7 juin 2021 sur la plateforme virtuelle de la Réunion.

Au nom de la SMC, je voudrais exprimer ma gratitude envers les partenaires de la Réunion d'hiver : l'Université d'Ottawa, Bolster Academy, l'AARMS, le CRM, l'Institut Fields, le PIMS et Maple.

Les directrices scientifiques, Ailana Fraser (University of British Columbia), Monica Nevins (University of Ottawa) et Mateja Šajna (University of Ottawa) ont investi beaucoup d'effort pour vous offrir un programme intéressant et divers et méritent notre reconnaissance et nos remerciements. Organiser un évènement scientifique d'une telle ampleur exige beaucoup de travail et de dévouement et cela n'aurait pas été possible sans les efforts des directrices scientifiques, des organisateurs et organisatrices des sessions et des membres du personnel de la SMC.

Enfin, je souhaite une Réunion fort stimulante et agréable à toutes et tous les participant.e.s. Bienvenue à notre Réunion d'été virtuelle !

Cordialement,



Javad Mashreghi,
Président, SMC

Ailana Fraser
(University of British Columbia)

Monica Nevins
(University of Ottawa)

Mateja Šajna
(University of Ottawa)

Welcome Letter from the Scientific Directors

Dear participants,

Welcome to the 75th (plus 1) anniversary meeting of the Canadian Mathematical Society! Planning for this meeting has been part of our lives since July 2018, and it is truly a joy to see it come to fruition.

While it is tempting to lament what almost was (A banquet at Dow's Lake! A three-tiered cake! Racing up and down stairs, between six or seven buildings, to get from session

Mot de bienvenue de les Directeurs scientifique

Cher et chère participant.e.s,

Bienvenue à la réunion du 75e (plus 1) anniversaire de la Société mathématique du Canada ! La planification de cette réunion a fait partie de nos vies depuis juillet 2018, et c'est une vraie joie de la voir s'actualiser.

Bien qu'il soit tentant de se lamenter sur ce que cette réunion aurait pu être (Un banquet au lac Dow ! Un gâteau à trois étages ! La course dans les escaliers, entre six ou sept bâtiments, pour se rendre d'une séance à l'autre !),

to session!), let's enjoy what is: one of the biggest summer meetings in the CMS's history, in a format we couldn't have dreamed of a couple of years ago, with innovation in teaching and collaboration exploding around us. What a fitting way to celebrate the dynamism of mathematics in Canada.

Our great thanks to our plenary speakers and session organizers, gracious in the face of much upheaval; to our Scientific Organizing Committee, and to the incredible staff at the CMS, especially Sarah Watson; and to you, the speakers and participants who make every meeting such a success.

So: cheers to the Canadian Mathematical Society, and cheers to us, the diverse and thriving Canadian mathematical community! May our 100th anniversary celebrations proceed more smoothly! !

Sincerely,

Ailana Fraser, Monica Nevins and Mateja Šajna

Your 2021 CMS Winter Meeting Scientific Directors

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profitons de ce qu'elle est : l'une des plus grandes réunions d'été de l'histoire de la SMC dans un format dont nous n'aurions pas pu rêver il y a quelques années avec des innovations en enseignement et en collaboration partout autour de nous. Quelle façon appropriée de célébrer le dynamisme des mathématiques au Canada !

Nous tenons à remercier nos conférenciers.ières et les organisateurs.trices des séances plénières qui ont fait preuve d'une grande amabilité malgré les bouleversements : notre comité d'organisation scientifique et le personnel formidable de la SMC, en particulier Sarah Watson ;

et vous, les conférenciers.ières et les participant.es qui font de chaque réunion un tel succès.

Alors : Vive la Société mathématique du Canada et vive la communauté mathématique canadienne diversifiée et florissante dont nous faisons partie ! Que les célébrations de notre 100e anniversaire se déroulent sans encombre !

Cordialement

Ailana Fraser, Monica Nevins et Mateja Šajna

Directeurs scientifiques de la Réunion d'été 2021 de la SMC

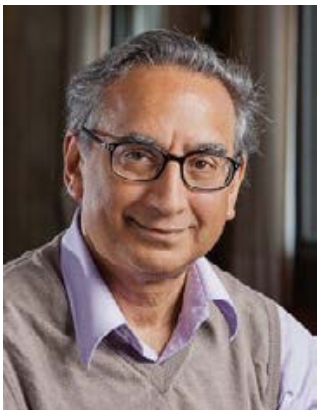
Scientific Organizing Committee / Comité scientifique

Benoit Collins
(Kyoto University)

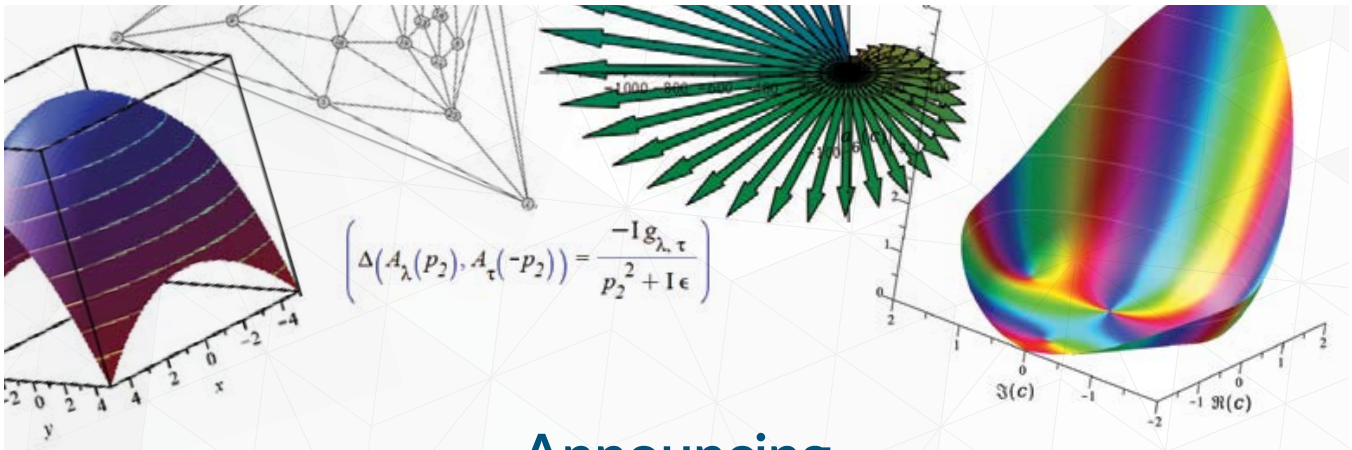
Dr. Anita Layton
(University of Waterloo)

Kathryn Mann
(Cornell)

Robert McCann
(University of Toronto)



M. Ram Murty
(Queen's University)



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Coxeter-James Prize

Dr. Luke Postle (University of Waterloo)

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Luke Postle (University of Waterloo) has been named the recipient of the 2021 Coxeter-James Prize for his work in the area of graph theory. Dr. Postle will receive his award and present a prize lecture during the CMS Winter Meeting in December 2021.

Dr. Luke Postle is an exceptional young researcher in structural graph theory, earning his Ph.D. in 2012 in the Department of Mathematics at the Georgia Institute of Technology. He quickly earned a strong international reputation by using a broad and innovative range of tools to solve old and

Prix de Coxeter-James

Dr. Luke Postle (University of Waterloo)

La Société mathématique du Canada (SMC) est heureuse d'annoncer que Luke Postle (Waterloo) a été nommé lauréat du prix Coxeter-James 2021 pour son oeuvre dans le domaine de la théorie des graphes. M. Postle recevra son prix et présentera une conférence à la Réunion d'hiver de la SMC en décembre 2021.

M. Postle est un jeune chercheur exceptionnel en théorie des graphes structurels. Il a obtenu son doctorat en 2012 au département de mathématiques du Georgia Institute of Technology. Il s'est rapidement forgé une réputation mondiale par l'application d'un large éventail d'outils innovants pour résoudre des problèmes profonds de longue date en combinatoires. Il a apporté d'importantes contributions à la résolution de problèmes difficiles et de longue date dans la coloration de graphe.

M. Postle s'est établi comme un chercheur important en coloration de graphe. Il a publié dans des revues prestigieuses telles que *Journal of Combinatorial Theory B* (JCTB), *Combinatorica, et Journal of Graph Theory*,

deep problems in combinatorics. He made several significant contributions, to difficult, important, and longstanding open problems in graph colouring.

Dr. Postle established himself as a leading researcher in graph theory. He published in the top journals such as *Journal of Combinatorial Theory B* (JCTB), *Combinatorica, and Journal of Graph Theory*, and gave talks at conferences and universities around the world. He made groundbreaking progress on many famous conjectures in graph colouring, including Hadwiger's Conjecture, the Goldberg-Seymour Conjecture, Reed's Conjecture, and Jaeger's Conjecture.

Luke Postle has launched a new paradigm in graph coloring with his introduction of a new generalization of coloring. Namely in 2015, Luke Postle and his collaborator Zdenek Dvorak introduced correspondence colouring in article published in JCTB, now referred to as DPcolouring by the community after their surnames. Correspondence colouring is a generalization of list colouring. List colouring, itself a generalization of colouring, was first introduced by Erdos, Rubin and Taylor in the 1970s and is now the subject of over a thousand journal articles. In list colouring each vertex has its own list from which it must be coloured. In correspondence colouring, they abstracted this by removing any `global' notion of colour and rather only using a `local' notion, individual to each vertex. Such a generalization can actually be used for inductive purposes to solve list colouring problems, namely they used the concept to solve a 15-year-old conjecture that planar graphs without 4 to 8 cycles are 3-list-colourable. Since then, their article has garnered 86 citations in 3 years according to Google Scholar and indeed the article is listed on JCTB's own website as its most cited article published since January 2018. Correspondence colouring has been used both to solve open colouring problems and been studied in its own right as a natural form of colouring. For example, correspondence colouring proved a key ingredient in Luke Postle's research on Reed's conjecture.

Dr. Postle is currently an Associate Professor in the Department of Combinatorics and Optimization at the University of Waterloo. Since joining Waterloo in 2014, he was awarded a Tier 2 Canada Research Chair and an Early Researcher Award from the government of Ontario.

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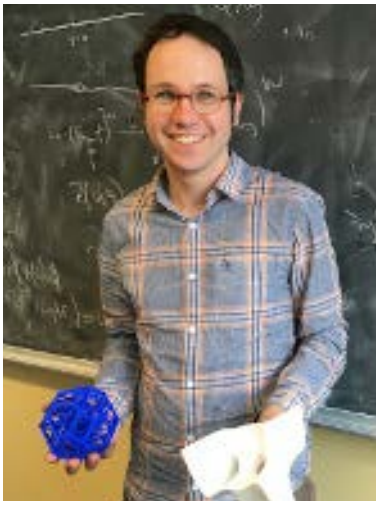
et a livré des conférences lors des congrès et dans les cadres universitaires partout dans le monde. Il a réalisé des développements innovants dans de nombreuses conjectures célèbres en coloration de graphe, dont la Conjecture de Hadwiger, ainsi que celles de Goldberg-Seymour, de Reed et de Jaeger.

Luke Postle a amorcé un changement de paradigme en matière de coloration de graphe en proposant une nouvelle généralisation du concept de coloration. En effet, en 2015 Luke Postle et Zdenek Dvorak, son collaborateur, ont introduit dans un article publié dans JCTB le concept de coloration de correspondance qui est désormais désigné par la communauté sous l'appellation DP-coloration en leurs noms. Les colorations de correspondances constituent une généralisation des colorations sur listes. Ces dernières, qui généralisent elles-mêmes les colorations, ont été introduites par Erdös, Rubin et Taylor dans les années 1970 et font maintenant l'objet de plus d'un millier d'articles. Dans les colorations sur listes, chaque sommet se voit assigner une liste à partir de laquelle il doit être coloré. Dans les colorations de correspondance, en revanche, on remplace, par abstraction, toute notion « globale » de couleur par une notion « locale », propre à chaque sommet. Une telle généralisation peut être utilisée à des fins d'induction pour solutionner des problèmes de coloration de listes, comme ce fut le cas lorsque ce concept fut utilisé pour démontrer une conjecture qui était en suspens depuis 15 ans et stipulant que les graphes planaires sans cycles de longueurs 4 à 8 sont 3-L-colorables. Depuis lors, leur article a – selon Google scholar – cumulé pas moins de 86 citations en 3 ans ce qui lui a valu au sommet du palmarès publié sur le site de JCTB des articles cités le plus souvent depuis janvier 2018. Les colorations de correspondance ont été utilisées pour résoudre plusieurs problèmes en suspens en plus d'avoir été étudiées en eux-mêmes, c'est-à-dire en tant que forme naturelle de coloration. À titre d'exemple, les colorations de correspondance ont joué un rôle clé dans les recherches menées par Luke Postle sur la conjecture de Reed.

M. Postle est actuellement Professeur agrégé au Department of Combinatorics and Optimization à l'University of Waterloo. Depuis son arrivée à l'Université de Waterloo en 2014, il a reçu une chaire de recherche du Canada de niveau 2 et le prix de jeunes chercheurs du gouvernement de l'Ontario.



Jeffery-Williams Prize

Dr. Joel Kamnitzer (University of Toronto)

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Joel Kamnitzer (University of Toronto) is the recipient of the 2021 Jeffery-Williams Prize, which recognizes outstanding and sustained contributions to mathematical research by a member of the Canadian mathematical community.

Joel Kamnitzer received his PhD in 2005 at the University of California in Berkeley under the supervision of Allen Knutson, with a thesis on Mirkovic-Vilonen cycles.

Prix Jeffery-Williams

Dr. Joel Kamnitzer (University of Toronto)

La Société mathématique du Canada (SMC) est heureuse d'annoncer que le professeur Joel Kamnitzer (Toronto) est le lauréat 2021 du prix Jeffery-Williams de la SMC pour ses contributions à la recherche mathématique. Le professeur Kamnitzer recevra son prix et présentera une conférence à la Réunion d'été de la SMC qui se tiendra en juin 2020.

Joel Kamnitzer a obtenu son doctorat en 2005 à l'University of California in Berkeley sous la direction d'Allen Knutson, sa thèse de doctorat portant sur les cycles Mirkovic-Vilonen. Il a ensuite poursuivi des recherches postdoctorales au Mathematical Sciences Research Institute (MSRI). M. Kamnitzer est professeur à l'Université de Toronto depuis 2008 (titulaire depuis 2016).

La SMC reconnaît le professeur Kamnitzer comme un chef de file mondial dans le domaine de la théorie

He held postdoctoral positions at the Massachusetts Institute of Technology (MIT), at UC Berkeley, and the Mathematical Sciences Research Institute (MSRI). He joined the faculty of the University of Toronto in 2008, where he is full professor since 2016.

The CMS recognizes Dr. Kamnitzer as a world leader in the field of geometric representation theory. He has had some of the most original and influential contributions of the past 20 years in his field.

His field of research can be described as an interface between algebra, geometry and modern mathematical physics. Among his recent interests are the categorification program and algebraic problems in modern mathematical physics.

One particular strand of Dr. Kamnitzer's research is a novel approach to knot homology based on the study of the affine Grassmannian, an infinite-dimensional manifold which is one of the main objects of modern geometric representation theory. In particular, he developed a geometric approach to categorification of knot homology.

Another important contribution of Dr. Kamnitzer is his work on symplectic duality, which involves the quantization of certain slices of the affine Grassmannian.

Dr. Kamnitzer was the recipient of the André Aisenstadt Prize of CRM in 2011, and has held a Simons Fellowship as well as an E.W.R. Steacie Memorial Fellowship. He has published widely, always in top journals, and is a regular speaker at international mathematical venues. He has won teaching awards, and is an influential educator, having supervised 14 PhD students and 11 MSc students to date.

Joel Kamnitzer is a world-class mathematician whose influence significantly advanced a big portion of modern mathematics. The CMS is proud to award him the 2021 Jeffery-Williams Prize. Dr. Kamnitzer will give the Jeffery-Williams Prize Lecture at the Summer Meeting of the CMS in Ottawa.

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des représentations géométriques. Il a à son actif des contributions les plus originales et les plus importantes des 20 dernières années dans ce domaine.

Son champ de recherche se qualifie comme une interface entre l'algèbre, la géométrie et la physique mathématique moderne. Parmi ses plus récents intérêts de recherche figurent le programme de catégorification et les problèmes algébriques de la physique mathématique moderne.

L'un des points saillants des recherches du professeur Kamnitzer est une approche inédite en homologie des espaces de noeuds reposant sur l'étude de la Grassmanienne affine, une variété de dimension infinie comptant parmi les principaux objets d'étude en théorie géométrique des représentations actuelle. Il a notamment élaboré une approche géométrique de catégorification de l'homologie des espaces de noeuds.

Une autre des principales contributions du professeur Kamnitzer porte sur la dualité symplectique et concerne la quantification de certaines tranches de la Grassmannienne affine.

M. Kamnitzer a remporté le prix André Aisenstadt du CRM en 2011. Il a été titulaire d'une bourse Simons et de la bourse commémorative E.W.R. Steacie. Joel Kamnitzer a publié de nombreux articles dans des revues prestigieuses et délivre régulièrement des conférences aux évènements mathématiques internationaux. Il a également remporté des prix d'enseignement et est un enseignant influent, ayant dirigé 14 doctorant.e.s et 11 étudiant.e.s à la maîtrise.

Joel Kamnitzer est un mathématicien de classe mondiale dont l'influence a contribué à l'avancement des mathématiques modernes. La SMC est fière de lui remettre le prix Jeffery-Williams 2021.

Krieger-Nelson Prize

Dr. Anita Layton (University of Waterloo)

The Canadian Mathematical Society (CMS) is pleased to announce that Dr. Anita Layton (University of Waterloo) has been named the recipient of the 2021 Krieger-Nelson Prize for her exceptional contributions to mathematical research with applications ranging from fluid dynamics to biology and medicine. Dr. Layton will receive her award and present a prize lecture during the CMS Summer Meeting in June 2021.

After earning a PhD in Computer Science from University of Toronto, Dr. Layton has built an impressive academic career with accomplishments throughout applied mathematics and the sciences. She was a long-time faculty member at Duke University where she held the Robert R. and Katherine B. Penn Professorship of Mathematics. Recently she moved to the University of Waterloo as a Canada 150 Research Chair in Mathematical Biology and Medicine.

Prix Krieger-Nelson

Recipient (Simon Fraser University)

La Société mathématique du Canada (SMC) est heureuse d'annoncer que M^{me} Anita Layton (UWaterloo) est la lauréate 2021 du prix Krieger-Nelson pour sa contribution exceptionnelle à la recherche mathématique et ses applications allant de la dynamique des fluides à la biologie et à la médecine. Elle recevra son prix et présentera la conférence Krieger-Nelson à la Réunion d'été de la SMC, qui se tiendra en juin 2021.

Après avoir obtenu un doctorat en informatique à l'Université de Toronto, M^{me} Layton s'est forgé une carrière universitaire impressionnante avec de nombreuses réalisations en mathématique appliquées et en science. Elle a longtemps été professeure à la Duke University où elle a occupé la chaire Robert R. et Katherine B. Penn en mathématiques. Elle s'est récemment joint à l'University of Waterloo où elle occupe la chaire de recherche Canada 150 en biomathématique et en médecine.

M^{me} Layton a été reconnue comme une chercheuse influente en mathématiques appliquées à l'intersection du calcul mathématique et des sciences biomédicales

Dr. Layton has been recognized as a distinguished figure in the applied mathematics research at the interface of mathematical computation and biomedical sciences with direct impact in clinical health care. She is the author of over 170 publications that include top journals in applied mathematics, physiology, and medicine.

In addition to Dr. Layton's ground breaking work in mathematical biology, she has also published many impactful and wellcited studies in computational fluid dynamics; in particular, computational methods for fluid-structure interaction problems. Here, a deformable object is immersed in an incompressible fluid so that the object moves with the fluid and also exerts forces on it. These problems are notoriously hard to solve, both analytically and computationally. Dr. Layton has been at the forefront of studying and developing numerical methods which preserve the sharp fluid-boundary interface. For example, with then colleague Tom Beale, she was the first to present a rigorous analysis of the immersed interface method of Li and LeVeque.

Dr. Layton's expertise on systems of nonlinear advection-diffusion equations coupled with algebraic equations has, in part, furnished her long-standing program of research on kidney function, and specifically on the kidney's ability to concentrate salt and other products in the outflow. Here she has addressed important problems in physiology and medicine, and corrected several misconceptions about kidney function that have plagued the textbooks for years. By working with renal physiologists, Layton was able to develop a model of fluid and solute exchange in the kidney that accounts for its concentrating ability. She developed a fast numerical solver that proved to be vital as it allowed for parameter sensitivity studies that are based on many repetitions of otherwise time-consuming and costly simulations.

It is worth noting that Dr. Layton's work has inspired new experimental and clinical studies in the area of renal physiology and associated medical care. Her work has also highlighted the importance of sex differences in mathematical models for biological systems. Overall, Dr. Layton is an outstanding applied mathematician whose impact is vast and truly interdisciplinary. The CMS is proud to award her the 2021 Krieger-Nelson Prize.

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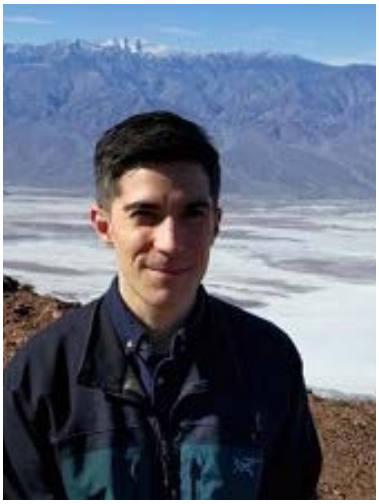
avec un impact direct sur les soins de santé cliniques. Elle est l'auteure de plus de 170 articles publiés dans des revues prestigieuses des mathématiques appliquées, de la physiologie et de la médecine.

En plus de son travail innovateur en biologie mathématique, Madame Layton a également publié de nombreuses études percutantes en dynamique des fluides computationnelle, et plus précisément sur les méthodes de calcul pour les problèmes d'interaction des structures fluides. Selon cette méthode, un objet déformable est immergé dans un fluide incompressible de sorte que l'objet se déplace avec le fluide tout en lui exerçant des forces. Ces problèmes sont notoirement difficiles à résoudre, tant sur le plan analytique que sur le plan informatique. Anita Layton a été à l'avant-garde de la recherche et l'élaboration de méthodes numériques qui préservent une couche limite marquée. À titre d'exemple, elle a été la première chercheuse à présenter une analyse rigoureuse de la méthode d'interface immergée de Li et de LeVeque avec son ancien collègue, Tom Beale.

L'expertise d'Anita Layton dans le domaine de systèmes d'équations d'advection-diffusion non linéaires et d'équations algébriques a nourri en partie son programme de recherche de longue date sur la fonction rénale et plus particulièrement sur la capacité du rein à concentrer le sel et d'autres produits dans le flux sortant. Elle a notamment abordé de problèmes importants de physiologie et de médecine, et a rectifié de fausses perceptions sur la fonction rénale répandues pendant des années dans les manuels universitaires. Travaillant avec des physiologistes rénaux, Layton a élaboré un modèle d'échange des fluides et des solutés dans le rein qui rend compte de sa capacité de concentration. Elle a développé un résolveur numérique rapide qui s'est avéré vital puisqu'il a facilité l'étude des paramètres sensibles entraînant de nombreuses répétitions de stimulations qui auraient autrement été longues et chères.

En effet, le travail d'Anita Layton a inspiré de nouvelles études expérimentales et cliniques dans le domaine de la physiologie rénale et des soins de santé qui y correspondent. Ses recherches ont aussi mis en évidence l'importance des différences entre les sexes dans le modèle mathématique des systèmes biologiques.

Enfin, Anita Layton est une mathématicienne exceptionnelle dont l'influence est vaste et interdisciplinaire. La SMC est fière de lui décerner le prix Krieger-Nelson 2021.



Cathleen Synge Morawetz Prize

Dr. Ailana Fraser (University of British Columbia)
Dr. Marco Gualtieri (University of Toronto)

The Canadian Mathematical Society is pleased to announce that the first annual Cathleen Synge Morawetz Prize for an outstanding research publication, or a series of closely related publications, was awarded in the fields of Geometry and Topology to Dr. Ailana Fraser and Dr. Marco Gualtieri.

Ailana Fraser is an outstanding mathematician in the fields of differential geometry and geometric analysis. She has been awarded the Cathleen Synge Morawetz Prize for her sequence of works which connect the theory of minimal surfaces with free boundary conditions and extremal problems for the Steklov eigenvalues on the space of Riemannian metrics. The work overlaps several different areas including the geometric calculus of variations, conformal geometry, and partial differential equations. It has opened new and unexpected research directions. Highlights of the work include, but are not limited to, three major publications:

1. Ailana Fraser and Richard Schoen, The firs Steklov eigenvalue, conformal geometry, and minimal surfaces, *Advances in Mathematics* 226 (2011), no. 5, 4011-4030.
2. Ailana Fraser and Richard Schoen, Sharp eigenvalue bounds and minimal surfaces in the ball, *Inventiones Mathematicae* 203 (2016), no. 3, 823-890.
3. Ailana Fraser and Richard Schoen, Shape optimization for the Steklov problem in higher dimensions, *Advances in Mathematics* 348 (2019), 146-162.

Professor Fraser received her B.Sc. in Mathematics from the University of Toronto in 1993, and her Ph.D. from Stanford University in 1998. She held postdoctoral positions at the Courant Institute of Mathematical Sciences (NYU) and at Brown University, before joining the University of British Columbia in 2002, where she is currently a Full Professor in the Department of Mathematics.

Professor Fraser has been invited to give presentations at numerous international venues, including Oberwolfach, MSRI, BIRS, the Clay Mathematics Institute, and the Institute for Advanced Study in Princeton. She has been an active member of the mathematical community, with contributions as organiser and scientific director at CMS conferences and sessions, PIMS and BIRS workshops, and many other conferences. She serves as Editor and Associate Editor of leading journals (e.g. *Transactions of the AMS, Memoirs of the AMS, Journal of Geometric Analysis, Canadian Journal of Mathematics, Canadian Mathematical Bulletin*).

Professor Fraser is a Fellow of the CMS and of the AMS, and received the 2012 CMS Krieger-Nelson Prize.

Ailana Fraser's publications referenced above are outstanding, and have had a profound impact in her areas of research. The CMS is delighted to award her the inaugural Cathleen Synge Morawetz Prize.

Marco Gualtieri is an outstanding mathematician the fields of differential geometry and complex geometry. He has been awarded the Cathleen Synge Morawetz Prize for his work on the foundations of generalized complex structures. This work opens up new connections between symplectic geometry and complex geometry, by initiating the study of a class of manifolds which interpolates between symplectic manifolds on the one hand, and complex manifolds on the other. Applications to Mirror Symmetry and String Theory abound. The principal paper the prize is awarded for is

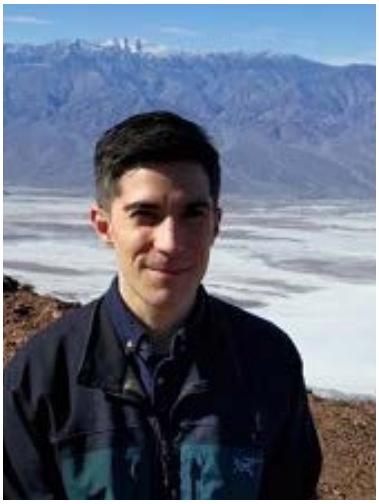
- Marco Gualtieri, Generalized complex manifolds, *Annals of Mathematics* 174 (2011), no. 1, 75–123.

Professor Gualtieri received his B.Sc in Mathematics from McGill University in 1999. He received a Rhodes Scholarship to study at the University of Oxford, where he obtained his D.Phil. in 2004, under the direction of Nigel Hitchin. He held postdoctoral positions at the Mathematical Sciences Research Institute (MSRI) in Berkeley and the Fields Institute of Mathematical Sciences. He was C.L.E. Moore Instructor at the Massachusetts Institute of Technology (MIT), before joining the University of Toronto in 2008, where he is Full Professor since 2016.

Professor Gualtieri is a regular participant at international conferences in Geometry, and has been invited to a great many centres of mathematical research, including CRM Montreal, BIRS, CERN, the Perimeter Institute, and the Fields Institute.

In 2010, Professor Gualtieri won the Lichnerowicz Prize in Poisson geometry, and in 2012 the André Aisenstadt Prize for outstanding achievements by a young Canadian mathematician. The CMS awarded the Coxeter-James Prize Lectureship to Dr. Gualtieri in 2014.

Professor Gualtieri's Annals paper is a masterful combination of depth, clarity and concision. It shone a light on fruitful pathways and so illuminated many later journeys by him and others. The CMS is delighted that its author is a recipient of the inaugural Cathleen Synge Morawetz Prize.



Prix Cathleen Synge Morawetz

Dr. Ailana Fraser (University of British Columbia)
Dr. Marco Gualtieri (University of Toronto)

La Société mathématique du Canada est heureuse d'annoncer que le premier Prix Cathleen-Synge-Morawetz a été remis à la professeure Ailana Fraser et au professeur Marco Gualtieri.

Ailana Fraser est une mathématicienne exceptionnelle dans le domaine de la géométrie différentielle et de l'analyse géométrique. Le Prix Cathleen-Synge-Morawetz lui est décerné pour une série d'articles qui élaborent le lien entre la théorie des surfaces minimales bornées sans bords et les problèmes extrêmaux des valeurs propres de Steklov sur les variétés riemanniennes. Cette recherche recouvre plusieurs domaines différents, dont le calcul géométrique des variations, la géométrie conforme et les équations aux dérivées partielles. Elle a ouvert de nouvelles pistes de recherche inattendues. Les points saillants de cette recherche sont abordés, entre autres, dans trois publications principales :

1. Ailana Fraser and Richard Schoen, The first Steklov eigenvalue, conformal geometry, and minimal surfaces, *Advances in Mathematics* 226 (2011), no. 5, 4011-4030.
2. Ailana Fraser and Richard Schoen, Sharp eigenvalue bounds and minimal surfaces in the ball, *Inventiones Mathematicae* 203 (2016), no. 3, 823-890.
3. Ailana Fraser and Richard Schoen, Shape optimization for the Steklov problem in higher dimensions, *Advances in Mathematics* 348 (2019), 146-162.

La professeure Fraser a obtenu son baccalauréat ès sciences en Mathématiques de l'Université de

Toronto en 1993 et a terminé ses études doctorales à la Stanford University en 1998. Elle a occupé des postes postdoctoraux au Courant Institute of Mathematical Sciences (NYU) et à la Brown University avant de se joindre au Département de mathématiques de l'University of British Columbia en 2002 où elle est actuellement professeure titulaire.

Ailana Fraser a été invitée à livrer des conférences dans le cadre de nombreux évènements scientifiques internationaux, notamment à Oberwolfach, au MSRI, à la BIRS, au Clay Mathematics Institute et à l'Institute for Advanced Study de Princeton. Elle a été une membre active de la communauté mathématique et a servi la communauté en tant qu'organisatrice et directrice scientifique des réunions de la SMC, des ateliers du PIMS et de la BIRS et de nombreux autres congrès. Elle est rédactrice en chef et rédactrice adjointe des revues prestigieuses telles que Transactions of the AMS, Memoirs of the AMS, Journal of Geometric Analysis, Journal canadien de mathématiques, Bulletin canadien de mathématiques.

La professeure Fraser est Fellow de la SMC et de l'AMS et a reçu le Prix Krieger-Nelson 2012 de la SMC.

Les publications susmentionnées d'Ailana Fraser sont exceptionnelles et ont eu un impact profond dans ses domaines de recherche. La SMC est fière de lui décerner le premier Prix Cathleen-Synge-Morawetz.

Marco Gualtieri est un mathématicien exceptionnel dans les domaines de la géométrie différentielle et de la géométrie complexe. Le Prix Cathleen Synge Morawetz lui est remis pour son travail sur les fondations des structures complexes généralisées. Son travail tisse de nouveaux liens entre la géométrie symplectique et la géométrie complexe en mettant en oeuvre l'étude d'une classe de variétés interpolant entre des variétés symplectiques et des variétés complexes. Cette théorie a de nombreuses applications dans les domaines de la symétrie miroir et de la théorie des cordes. L'article principal du professeur Gualtieri qui traite de ces sujets et pour lequel il a reçu le Prix est

- Marco Gualtieri, Generalized complex manifolds, Annals of Mathematics 174 (2011), no. 1, 75–123.

Le professeur Gualtieri a reçu son Baccalauréat ès sciences en Mathématiques de l'Université McGill en 1999. Il a reçu une bourse de Rhodes pour étudier à l'Université Oxford d'où il a obtenu son doctorat en 2004 sous la direction de Nigel Hitchin. Il a occupé des postes postdoctoraux au Mathematical Sciences Research Institute (MSRI) à Berkeley et au Fields Institute of Mathematical Sciences. Il a été chargé de cours C.L.E Moore à Massachusetts Institute of Technology (MIT), avant de se joindre au Département de mathématiques de l'Université de Toronto où il est professeur titulaire depuis 2016.

Marco Gualtieri participe régulièrement aux congrès internationaux de la géométrie et a été invité à des centres de recherche mathématiques dont le CRM à Montréal, la BIRS, le CERN, le Perimeter Institute et le Fields Institute.

En 2010, le professeur Gualtieri a remporté le Prix Lichnerowicz en géométrie Poisson et en 2021 le prix André Aisenstadt décerné pour les réalisations exceptionnelles d'un jeune mathématicien canadien. Il a également remporté le Prix Coxeter-James de la SMC en 2014.

L'article du professeur Gualtieri, publié dans les Annals est une combinaison remarquable de profondeur, de clarté et de concision. Il a dévoilé des voies fructueuses et pour les mathématicien.ne.s à venir. La SMC est fière de lui décerné le premier Prix Cathleen-Synge-Morawetz.

CMS Excellence in Teaching Award

Alfonso Gracia-Saz (University of Toronto)

The Canadian Mathematical Society (CMS) is pleased to announce that professor Alfonso Gracia-Saz (UofT) has been named the 2021 recipient of the CMS Excellence in Teaching Award. Professeur Gracia-Saz will receive his award at the 2021 Summer Meeting which will be held virtually from June 7 to June 11.

It is said that when Dr. Gracia-Saz teaches, he reinvents teaching. His work with the University of Toronto's legendary MAT137 (Calculus with Proof) is an excellent example of his dynamic teaching style; his reorganization, his attention to detail, his famous problem sets, and his inspiring lectures and videos have given this challenging course a new level of energy– particularly significant in this recent time of pandemic challenge. A second example is found in his design of the instructor training program at the University of

Prix d'excellence en enseignement

Alfonso Gracia-Saz (University of Toronto)

La Société mathématique du Canada (SMC) est fière d'annoncer qu'elle remettra son Prix d'excellence en enseignement 2021 au professeur Alfonso Gracia-Saz (University of Toronto). M. Gracia-Saz présentera une conférence et recevra son prix à la Réunion d'été de la SMC, qui se tiendra en ligne du 7 au 11 juin 2021.

Il est dit que lorsque le professeur Gracia-Saz enseigne, il réinvente l'enseignement. Sa méthodologie pédagogique pour le fameux cours MAT137 (« Calcul avec preuves ») de l'Université de Toronto met en évidence son style dynamique d'enseignement. La façon dont il réorganise le cours, son souci du détail, ses célèbres ensembles de problèmes et ses conférences et ses capsules vidéos inspirantes ont apporté un niveau d'énergie impressionnant à ce cours difficile dont l'enseignement est encore plus complexe pendant la pandémie. Un deuxième exemple qui témoigne des aptitudes supérieures de M. Gracia-Saz est son programme de formation d'enseignant.e.s à l'Université de Toronto. Élaboré par lui, ce programme est maintenant déployé pour la formation de tou.te.s les assistant.e.s d'enseignement au département de mathématiques.

Toronto, a program that has now been extended to all Teaching Assistants in the Mathematics Department.

According to his Toronto colleague, Professor Galvao-Sousa, Professor Gracia-Saz "belongs to this rare breed of born teachers that possess not only the knowledge and creativity but also the warm and dynamic personality that allows him to teach students in such a natural way that the barrier between teacher and student ceases to exist."

Jeremy Quastel, the Chair of the Mathematics Department at Toronto makes it clear that Alfonso Gracia-Saz' work with MAT137 was a great achievement:

Peter Taylor, the Chair of the CMS Excellence in Teaching Award Committee, remarks:

Alfonso has very high standards and expects a strong commitment on the part of his students. But he is very generous with his time and makes it abundantly clear that he is more than willing to offer help to anybody who needs it. The upshot has been staggeringly good course evaluations for Alfonso personally, but also very good results for the course overall.

Alfonso Gracia-Saz obtained a Licenciatura (BSc) in both Physics and Mathematics from Universidad de Zaragoza (Spain), in 2000-2001, and a PhD in Mathematics from The University of California at Berkeley in 2006 (supervisor: Alan Weinstein). He held postdoctoral positions at Keio University (Japan) and University of Toronto before taking faculty positions first at the University of Victoria and then at the University of Toronto where he is now Associate Professor (Teaching Stream). His research interests are centred in active learning, inquiry-based learning, Poisson geometry and Lie algebroids.

Over the past 13 years, Alfonso has served as an instructor and the Academic Coordinator of the Canada/USA Mathcamp. His calculus YouTube channel with 200 videos has over 10,000 subscribers and well over 3 million views. He is active in mathematics outreach through competitions, math camps, science fairs and undergraduate research. He has worked in a prison university project (currently Mount Tamalpais College) and has written a mathematical play. He and his partner, Nick, enjoy contra dancing, cooking and complex board games.

Selon son collègue à l'Université de Toronto, le professeur Galvao-Sousa, M. Garcia-Saz « fait partie de ce rare groupe d'enseignant.e.s qui non seulement possèdent des connaissances et la créativité, mais sont aussi doté.e.s d'une personnalité chaleureuse et dynamique qui leur permet d'enseigner d'une manière naturelle qui élimine toute barrière entre professeur.e et étudiant.e. »

Jeremy Quastel, le directeur du département de mathématiques de l'Université de Toronto, affirme que le travail du professeur Alfonso Gracia-Saz en lien avec le MAT137 a été une grande réussite :

Alfonso à des attentes très élevées et exige un engagement concret de part de ses étudiant.e.s. Mais il est très généreux de son temps et fait savoir à ses étudiant.e.s qu'il est disposé à leur offrir de l'aide en tout temps. Par conséquent les évaluations de son cours ont été incroyablement bonnes, et le cours a été très réussi en général.

Peter Taylor, le président du comité du prix d'Excellence d'enseignement de la SMC remarque :

un facteur important contribuant au succès du professeur Gracia-Saz en tant qu'un professeur de mathématique exigent est le niveau élevé de la performance qu'il se fixe. À titre d'exemple, ses vidéos sont remarquables, tant sur le plan technique que sur le plan conceptuel, elles offrent une expérience à la fois stimulante et joyeuse.

Alfonso Gracia-Saz a obtenu son licenciatura (B.Sc.) en physique et en mathématiques de l'Université de Zaragoza, en Espagne, en 2000-2001, et son doctorat en mathématiques de l'Université de Californie à Berkeley en 2006 (sous la direction d'Alan Weinstein). Il a occupé des postes postdoctoraux à l'Université Keio au Japon et à l'Université de Toronto avant de devenir professeur d'abord à l'Université de Victoria et ensuite à l'Université de Toronto où il est actuellement professeur agrégé (volet Enseignement). Ses intérêts de recherche portent sur l'apprentissage actif et basé sur l'enquête, la géométrie de Poisson et les algébroïdes de Lie.

Au cours de treize dernières années, M. Gracia-Saz a été enseignant et coordonnateur académique des camps mathématiques Canada/US. Sa chaîne YouTube sur le calcul contient 200 vidéos et compte plus de 10 000 abonné.e.s et 2 millions vues. Il est présentement actif au sein des programmes de sensibilisation aux mathématiques à travers des concours, des camps, des expo-sciences et de la recherche de premier cycle. Il a travaillé dans le cadre d'un projet de l'université en prison (en cours actuellement au collège Mount Tamalpais) en Californie et a écrit une pièce de théâtre mathématique. Avec son conjoint, Nick, ils aiment la contredanse, la cuisine, et les jeux complexes de la société.

List of Abbreviations
Liste des abbréviations

AbCalc	Anything but Calculus! Alternatives to teaching Calculus in year 1 Les alternatives à l'enseignement du calcul en première année
ACNumTh	Additive and Combinatorial Number Theory Théorie additive des nombres et la combinatoire arithmétique
AlNumTh	Algebraic number theory Théorie algébrique des nombres
ApAlg	Operator algebras and applications Algèbres d'opérateurs et applications
APStoch	Applied Probability and Stochastic Processes La probabilité appliquée et les processus stochastiques
ArGeom	Arithmetic Geometry Géométrie arithmétique
BrMinTh	New perspectives on the Brunn-Minkowski theory Nouvelles perspectives sur la théorie de Brunn-Minkowski
CGameTh	Combinatorial Game Theory Théorie des jeux combinatoires
CxHarmA	Recent Advances in Complex and Harmonic Analysis Progrès récents dans l'analyse harmonique complexe
DesCode	Designs and codes Dessins et codes
Equity	Equity Forum Forum sur l'équité
ErgoTh	Ergodic Theory, Dynamical Systems, Fractals and Applications La théorie ergodique, les systèmes dynamiques, les fractales et les applications
ETAward	Excellence in Teaching Award Prix d'excellence en enseignement
FuncDEq	Recent advances in theory and applications of functional differential equations Progrès récents dans la théorie et les applications des équations différentielles fonctionnelles
GenRel	General Relativity Relativité générale
GeomAna	Geometric Analysis Analyse géométrique
GraphD	Graph decompositions Décompositions de graphes
GraphTh	Modern Trends in Graph Theory Tendances modernes de la théorie des graphes
Gröbner	Recent Developments in Gröbner Geometry Développements récents en géométrie de Gröbner
HarmAna	Harmonic Analysis and Partial Differential Equations Analyse harmonique et équations différentielles partielles
HistPh	History and Philosophy of Mathematics Histoire et philosophie des mathématiques
HopfAlg	Hopf Algebras and Related Topics Algèbres de Hopf et sujets connexes
IndigP	Transitioning to University: Indigenous Perspectives on Post-Secondary Mathematics La transition vers l'université : Perspectives autochtones sur les mathématiques postsecondaires
JWPrize	Jefferey-Williams Prize Prix Jefferey-Williams
KNPrize	Krieger-Nelson Prize Prix Krieger-Nelson
LDTopol	Low dimensional topology Topologie en basses dimensions

LPNumTh	The early Langlands Program and Number Theory Les débuts du programme Langlands et la théorie des nombres
MachLrn	Applications of Machine Learning Algorithms to Finance L'application des algorithmes de l'apprentissage automatique en finance
MIFin	Robust and model-independent finance La finance robuste et indépendante du modèle
ModelED	Mathematical models for ecological dynamics Modèles mathématiques en dynamiques écologiques
ModelEp	Mathematical modelling in epidemiology and public health La modélisation mathématique en épidémiologie et en santé publique
NLinAna	Nonlinear analysis on manifolds Analyse non linéaire dans les variétés différentielles
NoncGeo	Noncommutative Geometry and Mathematical Physics Géométrie non commutative et physique mathématique
OnlineT	Online teaching from now on Enseignement en ligne . . . A partir de maintenant
OpRes	Operations Research Recherche opérationnelle
OptTran	Optimal transport and applications Transport optimale et applications
padicGr	Representations of p-adic groups and Langlands correspondences Représentations de groupes p-adiques et correspondances de Langlands
Plenary	Plenary Lectures Conférences plénières
Poster	AARMS-CMS Student Poster Session Présentations par affiches des étudiants - AARMS-SMC
PubLec	Public Lecture Conférence publique
QuantIT	Quantum information theory Théorie de l'information quantique
QuantM	Quantum Mathematics Mathématiques quantiques
RLang	Amicale de théorie des nombres en hommage à Robert Langlands Amicale de théorie des nombres en hommage à Robert Langlands
StocPDE	Stochastic partial differential equations Équations aux dérivées partielles stochastiques
StudRes	STUDC Research Session Session StudC
SympGeo	Symplectic geometry Géométrie symplectique
VariAna	Variational Analysis: Theory and Applications Analyse Variationnelle : Théorie et Applications

Schedule for Business Meetings
Horaire pour Séances de travail

Friday June 4	**vendredi 4 juin**
12:30 - 17:30	CMS Board of Directors Meeting / Réunion du Conseil d'administration SMC

Friday June 11	**vendredi 11 juin**
14:00 - 15:00	CMS AGM / L'AGA de la SMC

Schedule for Related Activities
Horaire pour Activités sociales

Friday June 4	vendredi 4 juin
14:00 - 15:00	Break / Pause

Monday June 7	lundi 7 juin
10:45 - 11:00	Opening and Welcome / Ouverture et bienvenue
12:00 - 12:30	Bolster Academy - How to support 1st and 2nd-year non-math major students
12:00 - 12:30	Break / Pause
14:00 - 16:00	CMS-CMESG Joint Panel - Data Literacy
18:00 - 20:30	Student Social / Soirée étudiante

Tuesday June 8	mardi 8 juin
12:00 - 12:30	Break / Pause
14:30 - 15:00	Bolster Academy - Discuss best practices for online learning/teaching
14:30 - 15:00	Break / Pause

Wednesday June 9	mercredi 9 juin
12:00 - 12:30	Break / Pause
12:00 - 12:30	Balancing Mathematics and Life in COVID Times
14:30 - 15:00	Break / Pause
14:30 - 15:00	Balancing Mathematics and Life in COVID Times - Continued

Thursday June 10	jeudi 10 juin
12:00 - 12:15	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC
12:00 - 12:30	Break / Pause
12:00 - 12:30	Maple Transactions Journal Launch
14:30 - 15:00	Break / Pause
14:30 - 15:00	Food for thought: mathematics and film
14:30 - 15:00	AARMS-CMS Student Poster Session / Session de présentation par affiches pour étudiants AARMS-SMC

Friday June 11	vendredi 11 juin
12:00 - 12:30	Break / Pause
16:30 - 17:00	The CMS: 75 years in 15 minutes, by Graham Wright,

Schedule
Horaire

Monday June 7	lundi 7 juin
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13:30 - 14:00	Marissa Loving (Georgia Tech), *Covers, Curves, and Length Spectra*, LDTopol (p. 158)
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13:30 - 14:00	Karen Meagher (Regina), *2-Partially Intersecting Partitions*, DesCode (p. 116)
13:45 - 14:10	Roghayeh Maleki (University of Regina), *FOUR DIMENSIONAL ASSOCIATION SCHEMES HAVE CYCLOTOMIC CHARACTER VALUES*, StudRes (p. 238)
14:00 - 14:30	Yvon Verberne (Georgia Tech), *The asymptotic dimension of big mapping class groups*, LDTopol (p. 160)
14:10 - 14:35	Masoomeh Akbari (University of Ottawa), *Probabilistic Transitive Closure of Fuzzy Cognitive Maps: Algorithm Enhancement*, StudRes (p. 237)
15:00 - 15:20	Shubham Dwivedi (Humboldt University of Berlin), *Deformation theory of nearly* G_2 *manifolds*, NLinAna (p. 189)
15:00 - 15:30	Kodjo Raphaël Madou (Université Laval), *On admissible singular drifts of symmetric* α*-stable process*, CxHarmA (p. 220)
15:00 - 15:30	Mitja Mastnak (Saint Mary's University), *A cohomological approach to liftings*, HopfAlg (p. 153)
15:00 - 15:30	Lucia Moura (Ottawa), *Ordered Covering Arrays and NRT-metric Covering Codes*, DesCode (p. 117)
15:00 - 15:30	Artur Sowa (University of Saskatchewan), *Quantum applications of harmonic analysis on the group of positive rationals*, QuantM (p. 211)
15:30 - 15:50	Xi Sisi Shen (Northwestern University), *Estimates for metrics of constant Chern scalar curvature*, NLinAna (p. 192)
15:30 - 16:00	Almaz Butaev (University of Calgary), *On locally uniform domains in* $\mathbb{R}^n$, CxHarmA (p. 219)
15:30 - 16:00	Terry Gannon (University of Alberta), *Quantum SL2 and logarithmic vertex operator algebras*, HopfAlg (p. 152)
15:30 - 16:00	Ruizhong Wei (Lakehead), *On coded caching schemes*, DesCode (p. 118)
15:30 - 16:00	Jinglei Zhang (Institute for Quantum Computing), *SU(2) hadrons on a quantum computer*, QuantM (p. 213)
16:00 - 16:20	Freid Tong (Columbia University), *On the degenerations of asymptotically conical Calabi-Yau metrics*, NLinAna (p. 193)
16:00 - 16:30	Peter Kristel (University of Manitoba), *Connes fusion of the free fermions on the circle*, QuantM (p. 210)
16:00 - 16:30	Wenbo Li (University of Toronto), *Quasisymmetric Embeddability of Weak Tangents*, CxHarmA (p. 220)
16:00 - 16:30	Brett Stevens (Carleton), *The combinatorial game NOFIL played on Steiner triple systems*, DesCode (p. 118)
16:30 - 17:00	The CMS: 75 years in 15 minutes, by Graham Wright,

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Zou, Xingfu, *On a predator-prey system with digestion delay and anti-predation strategy*, FuncDEq (p. 229), Thursday June 10, 16:00 - 16:30

Public Lecture
Conférence publique

Schedule/Horaire

Wednesday June 9 **mercredi 9 juin**

17:00 - 18:00 Anne Broadbent (University of Ottawa), *The apple of my* ***i*** (p. 71)

Abstract/Résumé

ANNE BROADBENT, University of Ottawa

[Wednesday June 9 / mercredi 9 juin, 17:00]

The apple of my ***i***

What do ultra-secure communications, a longstanding open problem in operator algebra and boson sampling have in common ? These are all problems that are solved using quantum techniques.

In this public lecture, we discuss how quantum information is more like apples than oranges, and how this translates to a method for unforgeable money and ultra-secure communications. We then link this to quantum interactive proofs, the study of which have recently led to the unravelling of a 50-year old mathematical puzzle called the Connes embedding problem. Finally, we present boson sampling as the first ever demonstration of a computational advantage of quantum computers over conventional ones.

This public lecture is dedicated to first-year undergraduate students who often ask: "what good is linear algebra ?". My goal is to make this talk accessible to you, and to provide you with some answers to this very good question !

Plenary Lectures
Conférences plénières

Schedule/Horaire

Monday June 7	**lundi 7 juin**
11:00 - 12:00	Ian Putnam (University of Victoria), *Translation flows and operator algebras* (p. 73)

Tuesday June 8	**mardi 8 juin**
11:00 - 12:00	Aaron Naber (Northwestern University), *Connections between Geometry and Analysis on Manifolds and Path Spaces* (p. 73)

Wednesday June 9	**mercredi 9 juin**
11:00 - 12:00	Moon Duchin (TUFTS University), *Political Geometry* (p. 72)

Thursday June 10	**jeudi 10 juin**
11:00 - 12:00	Matilde Marcolli (University of Toronto), *Entropy, holography, and p-adic geometry* (p. 72)

Friday June 11	**vendredi 11 juin**
11:00 - 12:00	Henri Darmon (McGill University), *The unreasonable effectiveness of p-adic methods in number theory* (p. 72)

Abstracts/Résumés

HENRI DARMON, McGill
[Friday June 11 / vendredi 11 juin, 11:00]
The unreasonable effectiveness of p-adic methods in number theory

In a non-archimedean world, two subjects who walk away from each other, eager perhaps to observe current social distancing guidelines, might never succeed in coming more than one meter apart. Even worse, each successive step risks bringing them closer to each other than they ever were before, in a sequence of regularly spaced but increasingly egregious violations of sanitary rules. In spite of its paradoxical properties, the p-adic distance in such a world is well suited to number theory questions based on studying congruences, and forms the basis for an analysis that is just as rich and subtle as its real and complex counterparts. Some of the most central open problems in number theory, such as the Riemann hypothesis, the Birch and Swinnerton-Dyer conjecture, and the Stark conjecture admit p-adic variants which, far from being variants of concern, are significantly more tractable than their archimedean precursors. This lecture will describe the notable progress that has been achieved on these variants in the last decades, and attempt to explain what makes the progress possible.

MOON DUCHIN, Tufts University
[Wednesday June 9 / mercredi 9 juin, 11:00]
Political Geometry

The field of *political geography* is centered on questions of how nations, states, and districts are bounded and more broadly studies the spatialization of political processes. I'll discuss some active mathematical research areas—spanning combinatorics, probability, and geometry—inspired by questions of current interest in voting and civil rights.

This lecture is dedicated to the memory of Alfonso Gracia-Saz, an incomparable educator and human.

MATILDE MARCOLLI, Caltech and University of Toronto
[Thursday June 10 / jeudi 10 juin, 11:00]
Entropy, holography, and p-adic geometry

In the 1980s, Manin suggested that physics has "p-adic shadows" and that these p-adic counterparts can be used to better understand the ordinary formulation in terms of real and complex variables. This talk will illustrate how this idea can be applied to AdS/CFT holography, which relates gravity on a bulk space and conformal field theory on its boundary. In particular, holography predicts that information theoretic quantities like entanglement entropy on the boundary can be expressed in terms of geometric properties of the bulk. Instances of this relation can be established in terms of p-adic geometry.

AARON NABER, Northwestern University
[Tuesday June 8 / mardi 8 juin, 11:00]
Connections between Geometry and Analysis on Manifolds and Path Spaces

In the last decades there have been many connections made between the analysis of a manifold M and the geometry of M. Said correctly, there are now many ways to make precise that well-behaved analysis on M is 'equivalent' to the existence of lower bounds on Ricci curvature. Such ideas are the starting point for regularity theories and more abstract settings for analysis, including analysis on metric-measure spaces. We will begin this talk with an elementary review of these ideas.

More recently it has become apparent analysis on the path space PM of a manifold is closely connected to two sided bounds on Ricci curvature. Again, said correctly one can make an equivalence that the analysis on PM is well behaved iff M has a two sided Ricci curvature bound. As a general phenomena, one see's that analytic estimates on M lift to estimates on PM in the presence of two sided Ricci bounds. Our talk will mainly focus on explaining all the words in this abstract and giving some rough understanding of the broad ideas involved. Time allowing, we will briefly explain newer results with Haslhofer/Kopfer on differential harnack inequalities on path space.

IAN PUTNAM, University of Victoria
[Monday June 7 / lundi 7 juin, 11:00]
Translation flows and operator algebras

There has been a long history of important interactions between dynamical systems and operator algebras. The construction of operator algebras from dynamical systems has provided many enlightening examples. At the same time, operator algebra techniques have brought new ideas to the study of dynamics.

This talk will focus on a construction of certain dynamical systems on surfaces given by K. Lindsey and R. Trevino. Their starting data is a Bratteli diagram, a combinatorial object first used in the 1970's to describe a rich class of C*-algebras. The first goal is to relate these C*-algebras with those of the dynamics on the surface. The more ambitious goal is to exploit this relation to better understand the dynamics. The essence of this relation is the under-appreciated subtleties of decimal expansion (and some of its generalizations). This is joint work, in progress, with Rodrigo Trevino (Maryland).

Prize Lectures
Conférence des lauréats

Schedule/Horaire

Tuesday June 8 — **mardi 8 juin**

15:00 - 16:00 Joel Kamnitzer (University of Toronto) (p. 74)

Wednesday June 9 — **mercredi 9 juin**

15:00 - 16:00 Bernardo Galvao-Sousa (University of Toronto), *Alfonso !* (p. 74)

Thursday June 10 — **jeudi 10 juin**

15:00 - 16:00 Anita Layton (University of Waterloo), *His or Her Mathematical Models — Understanding Sex Differences in Physiology* (p. 74)

Abstract/Résumé

Excellence in Teaching Award
Prix d'excellence en enseignement

BERNARDO GALVAO-SOUSA, University of Toronto
[Wednesday June 9 / mercredi 9 juin, 15:00]
Alfonso !

For the last 7 years, Alfonso Gracia-Saz worked tirelessly in his course Calculus with Proofs (called "Calculus !").It had a huge impact on students, undergraduate and graduate, and professors. In the talk we will guide you through the story of Calculus ! and Alfonso's development as an educator.

Jefferey-Williams Prize
Prix Jefferey-Williams

JOEL KAMNITZER, University of Toronto
[Tuesday June 8 / mardi 8 juin, 15:00]

Krieger-Nelson Prize
Prix Krieger-Nelson

ANITA LAYTON, University of Waterloo
[Thursday June 10 / jeudi 10 juin, 15:00]
His or Her Mathematical Models — Understanding Sex Differences in Physiology

Imagine someone having a heart attack. Do you visualize the dramatic Hollywood portrayal of a heart attack, in which a man collapses, grabbing his chest in agony ? Even though heart disease is the leading killer of women worldwide, the misconception that heart disease is a men's disease has persisted. A dangerous misconceptions and risks women ignoring their own symptoms. Gender biases and false impressions are by no means limited to heart attack symptoms. Such prejudices exist throughout our healthcare system, from scientific research to disease diagnosis and treatment strategies. A goal of our research program is to address this gender equity, by identifying and disseminating insights into sex differences in health and disease, using computational modeling tools.

Additive and Combinatorial Number Theory
Théorie additive des nombres et la combinatoire arithmétique

Org: Jozsef Solymosi (UBC) and/et **Jacques Verstraete** (UC San Diego)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Lisa Sauermann (Institute for Advanced Study), *Finding solutions with distinct variables to systems of linear equations over $\mathbb{F}_p$* (p. 78)
13:00 - 13:30	Oliver Roche-Newton (Johann Radon Institute), *Additive and Multiplicative Sidon Sets* (p. 78)
13:30 - 14:00	Ernie Croot (Georgia Tech), *On a problem of Graham, Erdos, and Pomerance on the p-divisibility of central binomial coefficients* (p. 77)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Sophie Stevens (Johann Radon Institute), *Attaining the exponent 5/4 for the sum product problem in finite fields* (p. 79)
13:00 - 13:30	Thomas Bloom (University of Oxford), *Structure of large spectra: problems and constructions* (p. 76)
13:30 - 14:00	Brandon Hanson (University of Georgia), *Higher order convexity and iterated convolution* (p. 77)
14:00 - 14:30	Giorgis Petridis (University of Georgia), *Almost orthogonal sets over finite fields* (p. 78)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:00	Ilya Shkredov (Steklov Mathematical Institute), *On an application of higher energies to Sidon sets* (p. 79)
13:00 - 13:30	Sarah Peluse (Princeton/IAS), *Modular zeros in the character table of the symmetric group* (p. 77)
13:30 - 14:00	Ethan White (University of British Columbia), *The number of directions determined by a Cartesian product in finite fields* (p. 79)
14:00 - 14:30	Alex Iosevich (Rochester University), *Point configurations and applications* (p. 77)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Akos Magyar (University of Georgia) (p. 77)
13:00 - 13:30	Cosmin Pohoata (Yale University), *Perfect k-hash codes* (p. 78)
13:30 - 14:00	Chi Hoi Yip (University of British Columbia), *Gauss sums and the maximum cliques in generalized Paley graphs of square order* (p. 79)
14:00 - 14:30	Melvyn Nathanson (Lehman College (CUNY)), *Sidon sets for linear forms* (p. 77)

Abstracts/Résumés

THOMAS BLOOM, University of Oxford
[Tuesday June 8 / mardi 8 juin, 13:00]
Structure of large spectra: problems and constructions

Given a subset of a finite abelian group, its large spectrum is the set of Fourier coefficients which are unusually large in absolute value. Obtaining a deeper understanding of such sets, in particular how much additive structure they must have, has been at the heart of many of the advances in additive combinatorics in recent years.

For example, in recent joint work with Olof Sisask, building upon ideas of Bateman and Katz, we proved a particularly strong structural result about certain kinds of large spectrum, which allowed us to obtain new bounds for sets without three-term arithmetic progressions.

In this talk I will give a survey of our current understanding of such sets, what they can look like, and will highlight some of the gaps in our knowledge, in particular some conjectures that, if solved, should yield further progress on the bounds for sets without three-term arithmetic progressions.

ERNIE CROOT, Georgia Tech
[Monday June 7 / lundi 7 juin, 13:30]
On a problem of Graham, Erdos, and Pomerance on the p-divisibility of central binomial coefficients

This is joint work with Hamed Mousavi and Maxie Schmidt. We show that for any set of $r \geq 1$ sufficiently large primes $p_1, ..., p_r$, there are infinitely many integers n, such that $\binom{2n}{n}$ is divisible by these primes with multiplicity of size at most $o(\log n)$. This is equivalent to saying we can find integers n whose base p_1, base p_2, ..., and base p_r expansions all simultaneously have almost all their digits "small". Doing this for 2 primes at once (the case r=2) is not difficult (Erdos proved this version) ; but it is significantly more challenging to prove it for $r \geq 3$; in fact, Graham offered a large sum of money – and considered it to be one of his favorite problems – to solve the case r=3 for the primes $3, 5$, and 7. Our proof involves bypassing a deep, unsolved problem in diophanine approximation and algebraic number theory, called Schanuel's Conjecture, through the use of a number of methods from analytic number theory and additive combinatorics (and properties of generalized Vandermonde and totally positive matrices).

BRANDON HANSON, University of Maine
[Tuesday June 8 / mardi 8 juin, 13:30]
Higher order convexity and iterated convolution

We discuss recent progress on how the additive structure of a set of real numbers is perturbed by functions with non-vanishing derivatives. In particular, if a set A has sufficient additive structure and f is a sufficiently convex function, then there are relatively few solutions to $f(a_1) + ... + f(a_k) = f(a'_1) + ... + f(a'_k)$ for appropriate ranges of k. This is joint work with P. Bradshaw and M. Rudnev.

ALEX IOSEVICH, University of Rochester
[Wednesday June 9 / mercredi 9 juin, 14:00]
Point configurations and applications

We are going to discuss some recent results pertaining to the analytic and combinatorial aspects of finite point configurations. We shall discuss some applications of these ideas in frame theory and related areas.

AKOS MAGYAR, University of Georgia
[Thursday June 10 / jeudi 10 juin, 12:30]

MELVYN NATHANSON, LEHMAN COLLEGE (CUNY)
[Thursday June 10 / jeudi 10 juin, 14:00]
Sidon sets for linear forms

Let $\varphi(x_1, \ldots, x_h) = c_1x_1 + \cdots + c_hx_h$ be a linear form with coefficients in a field $\mathbf{F}$ and let V be a vector space over $\mathbf{F}$. A nonempty subset A of V is a *φ-Sidon set* if $\varphi(a_1, \ldots, a_h) = \varphi(a'_1, \ldots, a'_h)$ implies $(a_1, \ldots, a_h) = (a'_1, \ldots, a'_h)$ for all h-tuples $(a_1, \ldots, a_h) \in A^h$ and $(a'_1, \ldots, a'_h) \in A^h$. There exist infinite Sidon sets for the linear form φ if and only if the set of coefficients of φ has distinct subset sums. In a normed vector space with φ-Sidon sets, every infinite sequence of vectors is asymptotic to a φ-Sidon set of vectors. Results on p-adic perturbations of φ-Sidon sets of integers and bounds on the growth of φ-Sidon sets of integers are also obtained.

SARAH PELUSE, IAS/Princeton
[Wednesday June 9 / mercredi 9 juin, 13:00]
Modular zeros in the character table of the symmetric group

In 2017, Miller conjectured, based on computational evidence, that for any fixed prime p the density of entries in the character table of S_n that are divisible by p goes to 1 as n goes to infinity. I'll describe a proof of this conjecture, which is joint work with K. Soundararajan. I will also discuss the (still open) problem of determining the asymptotic density of zeros in the character table of S_n, where it is not even clear from computational data what one should expect.

GIORGIS PETRIDIS, The University of Georgia
[Tuesday June 8 / mardi 8 juin, 14:00]
Almost orthogonal sets over finite fields

The talk will be on joint work with Ali Mohammadi on the proof of a conjecture of Ahmadi and Mohammadian who studied a question of Erdos in the setting of vector spaces over finite fields: How large can a subset of $\mathbb{F}_q^n$ be with the property that among any three vectors there is an orthogonal pair ?

COSMIN POHOATA, Yale University
[Thursday June 10 / jeudi 10 juin, 13:00]
Perfect k-hash codes

A code of length n over an alphabet of size $k \geq 3$ is a subset $\mathcal{F}$ of $\{0, 1, \ldots, k-1\}^n$. Such a code is called a perfect k-hash code if for every subset of k distinct elements (or "codewords") of $\mathcal{F}$, say $\left\{c^{(1)}, \ldots, c^{(k)}\right\}$, there exists a coordinate i such that all these elements differ in this coordonate, namely $\left\{c_i^{(1)}, \ldots, c_i^{(k)}\right\} = \{0, 1, \ldots, k-1\}$. The problem of finding the maximum size of perfect k-hash codes is a fundamental problem in theoretical computer science, which turns out to be related with multiple famous questions in extremal and additive combinatorics. In this talk, we will quickly survey the state of the art and discuss some of these intriguing connections (and various natural open questions which arise).

OLIVER ROCHE-NEWTON, RICAM
[Monday June 7 / lundi 7 juin, 13:00]
Additive and Multiplicative Sidon Sets

An additive Sidon set is a set which contains no non-trivial solutions to the equation $a + b = c + d$. Multiplicative Sidon sets are defined analogously. This talk considers a problem about Sidon sets with a sum-product flavour: for an arbitrary set of real numbers A, is it guaranteed that A contains a large additive or multiplicative Sidon set ? In joint work with Audie Warren, we constructed a set which does not contain very large additive or multiplicative Sidon sets. I will discuss this construction and some other thoughts concerning this problem and similar ones.

LISA SAUERMANN, Institute for Advanced Study
[Monday June 7 / lundi 7 juin, 12:30]
Finding solutions with distinct variables to systems of linear equations over $\mathbb{F}_p$

Let us fix a prime p and a homogeneous system of m linear equations $a_{j,1}x_1 + \cdots + a_{j,k}x_k = 0$ for $j = 1, \ldots, m$ with coefficients $a_{j,i} \in \mathbb{F}_p$. Suppose that $k \geq 3m$, that $a_{j,1} + \cdots + a_{j,k} = 0$ for $j = 1, \ldots, m$ and that every $m \times m$ minor of the $m \times k$ matrix $(a_{j,i})_{j,i}$ is non-singular. Then we prove that for any (large) n, any subset $A \subseteq \mathbb{F}_p^n$ of size $|A| > C \cdot \Gamma^n$ contains a solution $(x_1, \ldots, x_k) \in A^k$ to the given system of equations such that the vectors $x_1, \ldots, x_k \in A$ are all distinct. Here, C and Γ are constants only depending on p, m and k such that $\Gamma < p$.

The crucial point here is the condition for the vectors $x_1, \dots, x_k$ in the solution $(x_1, \dots, x_k) \in A^k$ to be distinct. If we relax this condition and only demand that $x_1, \dots, x_k$ are not all equal, then the statement would follow easily from Tao's slice rank polynomial method. However, handling the distinctness condition is much harder, and requires a new approach. While all previous combinatorial applications of the slice rank polynomial method have relied on the slice rank of diagonal tensors, we use a slice rank argument for a non-diagonal tensor in combination with combinatorial and probabilistic arguments.

ILYA SHKREDOV, Steklov Mathematical Institute
[Wednesday June 9 / mercredi 9 juin, 12:30]
On an application of higher energies to Sidon sets

We show that for any finite set A and an arbitrary $\varepsilon > 0$ there is $k = k(\varepsilon)$ such that the higher energy $\mathrm{E}_k(A)$ is at most $|A|^{k+\varepsilon}$ unless A has a very specific structure. As an application we obtain that any finite subset A of the real numbers or the prime field either contains an additive Sidon-type subset of size $|A|^{1/2+c}$ or a multiplicative Sidon-type subset of size $|A|^{1/2+c}$.

SOPHIE STEVENS, Johann Radon Institute
[Tuesday June 8 / mardi 8 juin, 12:30]
Attaining the exponent 5/4 for the sum product problem in finite fields

The sum-product problem is to show, for any finite set A, that one of the sum set $A + A$ or product set AA must be large in cardinality. Progress on this problem over finite fields lags behind its counterpart in the reals, where notably in 1997 Elekes used the Szemerédi-Trotter theorem to obtain the exponent $5/4$; this exponent has since advanced in the reals. In a joint work with Ali Mohammadi, we show that if $A \subseteq \mathbb{F}_p$ has cardinality $|A| \ll p^{1/2}$ then we match Elekes' bound. That is, we show that

$$\max\{|A \pm A|, |AA|\} \lesssim |A|^{\frac{5}{4}} .$$

This improves the exponent of $11/9$ by Rudnev, Shakan and Shkredov from 2018.

ETHAN WHITE, UBC
[Wednesday June 9 / mercredi 9 juin, 13:30]
The number of directions determined by a Cartesian product in finite fields

The directions determined by a subset $U \subset \mathbb{F}_p^2$ is the set of slopes formed by pairs of points from U. Seminal results of Rédei and Szőnyi show that U determines at least $(|U| + 3)/2$ directions. In the case when $U = A \times B$, a Cartesian product, we improve the multiplicative constant and show that at least $|A||B| - |A| + 2$ directions are determined. When $A = B$ is an arithmetic progression, we further improve the multiplicative constant and give a precise asymptotic formula for the number of directions. Joint work with Daniel Di Benedetto, Greg Martin, Jozsef Solymosi, and Chi Hoi Yip.

CHI HOI YIP, University of British Columbia
[Thursday June 10 / jeudi 10 juin, 13:30]
Gauss sums and the maximum cliques in generalized Paley graphs of square order

Let $GP(q, d)$ be the d-Paley graph defined on the finite field $\mathbb{F}_q$. It is notoriously difficult to improve the trivial upper bound $\sqrt{q}$ on the clique number of $GP(q, d)$. In this talk, we will investigate the connection between Gauss sums over a finite field and maximum cliques of their corresponding generalized Paley graphs. In particular, we show that the trivial upper bound on the clique number of $GP(q, d)$ attains if and only if $d \mid (\sqrt{q} + 1)$, which strengthens the previous related results by Broere-Döman-Ridley and Schneider-Silva, as well as improves the trivial upper bound on the clique number of $GP(q, d)$ when $d \nmid (\sqrt{q} + 1)$.

Algebraic number theory
Théorie algébrique des nombres

Org: Alex Bartel (Glasgow) and/et **Antonio Lei** (Laval)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
16:00 - 16:30	Zheng Liu (UC Santa Barbara), *p-adic families of Yoshida lifts* (p. 83)
16:30 - 17:00	Giovanni Rosso (Concordia University), *Overconvergent Eichler–Shimura morphism for families of Siegel modular forms* (p. 83)
17:00 - 17:30	Francesc Castella (UC Santa Barbara), *On a conjecture of Darmon–Rotger in the adjoint CM case* (p. 81)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Alvaro Lozano-Robledo (University of Connecticut), *This talk is Galois-entangled with Harris Daniels' talk* (p. 83)
10:30 - 11:00	Eyal Goren (McGill University), *Foliations on Shimura varieties* (p. 82)
12:30 - 13:00	R. Sujatha (University of British Columbia), *Refined Iwasawa invariants* (p. 84)
13:00 - 13:30	Katharina Müller (University of Goettingen), *Iwasawa Invariants of fine Slemer groups of congruent abelian varieties* (p. 83)
13:30 - 14:00	Debanjana Kundu (University of British Columbia), *Arithmetic Statistics and Iwasawa Invariants of Elliptic Curves* (p. 82)
14:00 - 14:30	Jeffrey Hatley (Union College), *Recent progress in positive rank Iwasawa theory* (p. 82)
16:00 - 16:30	John Voight (Dartmouth College), *Definite quaternion orders with stable cancellation* (p. 84)
16:30 - 17:00	Julie Desjardins (University of Toronto), *Density of rational points on a family of del Pezzo surface of degree 1* (p. 81)
17:00 - 17:30	Harris Daniels (Amherst College), *This talk is Galois-entangled with Álvaro Lozano-Robledo's talk* (p. 81)

Wednesday June 9	**mercredi 9 juin**
10:00 - 10:30	Borys Kadets (University of Georgia), *Improving Weil bounds for abelian varieties* (p. 82)
10:30 - 11:00	Michele Fornea (Columbia University), *Plectic Stark-Heegner points* (p. 82)
12:30 - 13:00	Benjamin Breen (Clemson University), *Heuristics for narrow class groups and unit signatures of abelian number fields with odd degree.* (p. 80)
13:00 - 13:30	Chantal David (Concordia University), *One-Level density for cubic characters over the Eisenstein field* (p. 81)
13:30 - 14:00	Jiuya Wang (Duke University), *On Induced Characters with Positivity* (p. 84)
14:00 - 14:30	Matilde Lalin (Université de Montréal), *The Mahler measure of triangular polynomials* (p. 83)

Abstracts/Résumés

BENJAMIN BREEN, Clemson University

[Wednesday June 9 / mercredi 9 juin, 12:30]

Heuristics for narrow class groups and unit signatures of abelian number fields with odd degree.

We present heuristics for the behavior of a certain collection of ray class groups that arise when studying the narrow class group. These heuristics allow us to make predictions for unit signature ranks and the 2-torsion of narrow class groups. We

demonstrate our predictions and provide computational support for abelian extensions of degree n = 3,5,7. This is joint work with Ila Varma and John Voight.

FRANCESC CASTELLA, University of California Santa Barbara
[Monday June 7 / lundi 7 juin, 17:00]
On a conjecture of Darmon–Rotger in the adjoint CM case

Let E be an elliptic curve over $\mathbf{Q}$ such that $L(E,s)$ has sign $+1$ and vanishes at $s=1$, and let $p>3$ be a prime of good ordinary reduction for E. A construction of Darmon–Rotger attaches to E, and an auxiliary weight one cuspidal eigenform g such that $L(E,\mathrm{ad}^0(g),1)\neq 0$, a Selmer class $\kappa_p(E,g,g^*)\in \mathrm{Sel}(\mathbf{Q},V_pE)$. They conjectured that the following are equivalent: (1) $\kappa_p(E,g,g^*)\neq 0$, (2) $\dim_{\mathbf{Q}_p}\mathrm{Sel}(\mathbf{Q},V_pE)=2$.

In this talk I will outline a proof of Darmon–Rotger's conjecture when g has CM and $\mathrm{Sha}(E/\mathbf{Q})[p^\infty]<\infty$ (and some mild additional hypotheses). If time permits, I'll also say a few words about the ongoing extension of these results to the case of supersingular primes p. Based on joint work with Ming-Lun Hsieh.

HARRIS DANIELS, Amherst College
[Tuesday June 8 / mardi 8 juin, 17:00]
This talk is Galois-entangled with Álvaro Lozano-Robledo's talk

Let E be an elliptic curve defined over $\mathbb{Q}$. The adelic Galois representation attached to E (this object will be defined during the talk) captures all sorts of interesting information about the arithmetic of the points on $E(\overline{\mathbb{Q}})$, including data about the torsion subgroup, isogenies, and other finer invariants of the curve and its isogeny class. In this talk, and in Álvaro Lozano-Robledo's talk, we will give a summary of recent results towards the classification (up to isomorphism) of the possible adelic Galois representations that arise from elliptic curves over $\mathbb{Q}$. We will present some recent results of the authors and their collaborators (Álvaro Lozano-Robledo, Jackson Morrow) about the ways in which the division fields of an elliptic curve can be entangled. Our talks will be mostly self-contained, but very much related... entangled, if you will.

CHANTAL DAVID, Concordia University
[Wednesday June 9 / mercredi 9 juin, 13:00]
One-Level density for cubic characters over the Eisenstein field

We show that the one-level density for L-functions associated with the cubic residue symbols χ_n, with $n\in Z[\omega]$ square-free, satisfies the Katz-Sarnak conjecture for all test functions whose Fourier transforms are supported in $(-13/11,13/11)$, under GRH. This is the first result extending the support outside the trivial range $(-1,1)$ for a family of cubic L-functions. This implies that a positive proportion of the L-functions associated with these characters do not vanish at the central point $s=1/2$. A key ingredient is a bound on an average of generalized cubic Gauss sums at prime arguments, whose proof is based on the work of Heath-Brown and Patterson.

Joint work with Ahmet M. Guloglu.

JULIE DESJARDINS, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:30]
Density of rational points on a family of del Pezzo surface of degree 1

Let X be an algebraic variety over a number field k. We want to study the set of k-rational points X(k). For example, is X(k) empty ? If not, is it dense with respect to the Zariski topology ? Del Pezzo surfaces are classified by their degrees d, an integer between 1 and 9. Manin and various authors proved that for all del Pezzo surfaces of degree >1 is dense provided that the surface has a k-rational point (that lies outside a specific subset of the surface for d=2). For d=1, the del Pezzo surface always has a rational point. However, we don't know it the set of rational points is Zariski-dense. In this talk, I present a result, joint

with Rosa Winter, in which we prove the density of rational points for a specific family of del Pezzo surfaces of degree 1 over k.

MICHELE FORNEA, Columbia University
[Wednesday June 9 / mercredi 9 juin, 10:30]
Plectic Stark-Heegner points

Heegner points play a pivotal role in our understanding of the arithmetic of modular elliptic curves. They control the Mordell-Weil group of elliptic curves of rank 1, and they arise as CM points on Shimura curves. The work of Bertolini, Darmon and their schools has shown that p-adic methods can be successfully employed to generalize the definition of Heegner points to quadratic extensions that are not necessarily CM. Notably, Guitart, Masdeu and Sengun have defined and numerically computed Stark-Heegner (SH) points in great generality. Their computations strongly support the belief that SH points completely control the Mordell-Weil group of elliptic curves of rank 1.

In this talk I will report on joint works with Gehrmann, Guitart and Masdeu where we propose and numerically compute plectic generalizations of SH points. Inspired by Nekovar and Scholl's conjectures, we expect our points to control Mordell-Weil groups of higher rank elliptic curves.

EYAL GOREN, McGill University
[Tuesday June 8 / mardi 8 juin, 10:30]
Foliations on Shimura varieties

I report on joint work with Ehud De Shalit (Hebrew University). We consider two kinds of foliations on Shimura varieties. Although our program is quite general, I will focus on two examples to make the topic more digestible in 20 minutes. I will discuss the case of Hilbert modular surfaces and Picard modular surfaces.

JEFFREY HATLEY, Union College
[Tuesday June 8 / mardi 8 juin, 14:00]
Recent progress in positive rank Iwasawa theory

Many of the earliest results in the Iwasawa theory of elliptic curves and modular forms relied heavily on the finiteness of the relevant Selmer groups. In many natural settings, however, the relevant Selmer groups are not finite. In this talk, we will give a brief survey of some of the recent progress that has been made in generalizing classical results in Iwasawa theory to the positive rank setting.

BORYS KADETS, University of Georgia
[Wednesday June 9 / mercredi 9 juin, 10:00]
Improving Weil bounds for abelian varieties

Weil bounds for an abelian variety A over $\mathbb{F}_q$ give the following estimates $(\sqrt{q}-1)^{2\dim A} \leqslant |A(\mathbb{F}_q)| \leqslant (\sqrt{q}+1)^{2\dim A}$. I will talk about a simple approach to improving these bounds for high-dimensional simple abelian varieties over small fields. For example, when $q=2,3,4$ the lower Weil bound is vacuous. This method gives $|A(\mathbb{F}_3)| \geqslant 1.359^{\dim A}$ and $|A(\mathbb{F}_4)| \geqslant 2.275^{\dim A}$ for all but finitely many simple abelian varieties A. In contrast, for $q=2$ an infinite family of simple abelian varieties with only one point is known.

DEBANJANA KUNDU, UBC Vancouver
[Tuesday June 8 / mardi 8 juin, 13:30]
Arithmetic Statistics and Iwasawa Invariants of Elliptic Curves

In this talk, I will discuss recent results (joint with Anwesh Ray) where we study the average behaviour of the Iwasawa invariants for the Selmer groups of elliptic curves.

MATILDE LALIN, Université de Montréal
[Wednesday June 9 / mercredi 9 juin, 14:00]
The Mahler measure of triangular polynomials

The Mahler measure of a Laurent polynomial P is defined as the integral of $\log|P|$ over the unit torus with respect to the Haar measure. For multivariate polynomials, it often yields special values of L-functions. In this talk we will consider the Mahler measure of polynomials of the form $a(x)+b(x)y+c(x)z \in \mathbb{C}[x,y,z]$ where $a(x), b(x), c(x)$ are products of cyclotomic polynomials. We will exhibit the variety of these formulas, that could range from $\zeta(3)$ and dilogarithms to $L(E,3)$ (the L-function of an elliptic curve). This talk includes joint works with Jarry Gu and Siva Sankar Nair.

ZHENG LIU, University of California, Santa Barbara
[Monday June 7 / lundi 7 juin, 16:00]
p-adic families of Yoshida lifts

We construct a Hida family of Yoshida lifts for two given Hida families of modular forms, and compute the Petersson inner products of its specializations. The key step in the construction is to choose suitable Schwartz functions at p. The computation of the Petersson inner products can be viewed as a generalization of the computation in the works by Bocherer–Dummigan–Schulze-Pillot and Hsieh–Namikawa. Our computation makes use of an equivariant property of the chosen Schwartz functions at p for the action of U_p operators. This is an ongoing joint work with Ming-Lun Hsieh.

ALVARO LOZANO-ROBLEDO, University of Connecticut
[Tuesday June 8 / mardi 8 juin, 10:00]
This talk is Galois-entangled with Harris Daniels' talk

Let E be an elliptic curve defined over $\mathbb{Q}$. The adelic Galois representation attached to E (this object will be defined during the talk) captures all sorts of interesting information about the arithmetic of the points on $E(\overline{\mathbb{Q}})$, including data about the torsion subgroup, isogenies, and other finer invariants of the curve and its isogeny class. In this talk, and in Harris Daniels' talk, we will give a summary of recent results towards the classification (up to isomorphism) of the possible adelic Galois representations that arise from elliptic curves over $\mathbb{Q}$, and present some recent results of the authors and their collaborators (Garen Chiloyan, Harris Daniels, Jackson Morrow) in this area. Our talks will be mostly self-contained, but very much related... entangled, if you will.

KATHARINA MÜLLER, University of Göttingen
[Tuesday June 8 / mardi 8 juin, 13:00]
Iwasawa Invariants of fine Slemer groups of congruent abelian varieties

Let K be a number field and let A_1 and A_2 be abelian varieties defined over K. Assume that $A_1[p^l]$ and $A_2[p^l]$ are isomorphic as G_K-modules for some sufficient large l. Let K_∞ be a strongly Σ-admissible p-adic Lie extension (for a suitable set of primes Σ). Generalizing work of Greenberg-Vatsal and Lim-Sujatha we prove an inequality between the μ-invariants of the fine Selmer groups of A_1 and A_2 along the extension K_∞/K. If p^l annihilates the p-primary submodule of both Selmer groups we can even show that the μ-invariants are equal and that the p-primary subgroups are pseudo-isomorphic to each other. If K_∞/K is a $\mathbb{Z}_p$-extension we can derive relations of the corresponding λ-invariants – without assuming that μ vanishes.

This is joint work with Sören Kleine.

GIOVANNI ROSSO, Concordia
[Monday June 7 / lundi 7 juin, 16:30]
Overconvergent Eichler–Shimura morphism for families of Siegel modular forms

Classical results of Eichler and Shimura decompose the cohomology of certain local systems on the modular curve in terms of holomorphic and anti-holomorphic modular forms. A similar result has been proved by Faltings' for the étale cohomology of the modular curve and Falting's result has been partly generalised to Coleman families by Andreatta–Iovita–Stevens. In this talk, based on joint work with Hansheng Diao and Ju-Feng Wu, I will explain how one constructs a morphism from the overconvergent cohomology of GSp_{2g} to the space of families of Siegel modular forms. This can be seen as a first step in an Eichler–Shimura decomposition for overconvergent cohomology and involves a new definition of the sheaf of overconvergent Siegel modular forms using the Hodge–Tate map at infinite level.

R. SUJATHA, University of British Columbia
[Tuesday June 8 / mardi 8 juin, 12:30]
Refined Iwasawa invariants

This talk is based on joint work with Anwesh Ray. We will introduce Iwasawa theoretic invariants that are refinements of the classical mu-invariant in Iwasawa theory. A conjecture of Greenberg postulates the existence of one member in each isogeny class of elliptic curves over the rational numbers, which has the property that the mu-invariant for its dual Selmer group over the cyclotomic extension vanishes. We will explain how these refined invariants provide a philosophical reasoning for the validity of this conjecture.

JOHN VOIGHT, Dartmouth College
[Tuesday June 8 / mardi 8 juin, 16:00]
Definite quaternion orders with stable cancellation

Gauss conjectured (in the language of binary quadratic forms) that there are finitely many imaginary quadratic orders of class number 1. There are countless variants of this problem, involving mathematics that is both deep and ongoing. We will survey versions of the class number problem for quaternion orders. In particular, we enumerate all orders with cancellation in the stably free class group. This is joint work with Daniel Smertnig.

JIUYA WANG, Duke University
[Wednesday June 9 / mercredi 9 juin, 13:30]
On Induced Characters with Positivity

Classical result on induced characters shows that for non-cyclic groups any character can be decomposed into rational linear combinations of induced trivial representations from its subgroups. Motivated by recent progress in bounding ℓ-torsion in class groups of number fields, we are led to ask a similar question, but with the extra positivity constraints for the rational coefficients. We will give a full answer towards this question for regular representations, and we will also introduce its application in studying class groups. This is a joint work of Cui, Fleischer, Gu and Liu.

Org: Lucile Devin (Montréal & Ottawa), **Daniel Fiorilli** (Ottawa), **Damien Roy** (Ottawa) and/et **Gary Walsh** (Tutte Institute & Ottawa)

Schedule/Horaire

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16:30 - 17:00	Rachel Ollivier (University of British Columbia), *Une algèbre de Hecke dérivée dans le contexte du programme de Langlands* (p. 91)
17:00 - 17:30	Hugo Chapdelaine (Laval), *Correspondance thêta intégrale entre deux fonctions de Green λ-résolvante* (p. 86)

Tuesday June 8 — mardi 8 juin

10:00 - 10:30	Chantal David (Concordia), *Sommes de 2 carrés successives dans les progressions arithmétiques* (p. 86)
10:30 - 11:00	Lucile Devin (U. d'Ottawa et U. de Montréal), *Biais de Chebyshev et sommes de deux carrés* (p. 87)
12:30 - 13:00	Marc-Hubert Nicole (Institut mathématique de Marseille), *Le programme de Kudla p-adique en basses dimensions* (p. 91)
13:00 - 13:30	Lassina Dembélé (Université du Luxembourg), *Calcul des traces des opérateurs de Hecke sur les groupes orthogonaux* (p. 87)
13:30 - 14:00	Christelle Vincent (The University of Vermont), *Une banque de données sur les classes d'isogénie des variétés abéliennes sur les corps finis* (p. 92)
14:00 - 14:30	Aled Walker (CRM), *Problèmes extrémaux pour les plus grands diviseurs communs* (p. 93)
16:00 - 16:30	Ram Murty (Queen's University), *The vanishing of L-series and the Okada space* (p. 90)
16:30 - 17:00	Habiba Kadiri (Lethbridge), *Ideaux premiers dans le théorème de densité de Chebotarev pour tous les corps de nombres* (p. 88)
17:00 - 17:30	Alia Hamieh (University of Northern British Columbia), *Mean Values of Long Dirichlet Polynomials with Higher Divisor Coefficients* (p. 88)

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10:30 - 11:00	Anthony Poëls (Ottawa), *Approximation rationnelle et hypersurfaces quadratiques* (p. 91)
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14:00 - 14:30	Gary Walsh (Tutte Institute & Ottawa), *Computing Power Integral Bases of Pure Quartic Fields* (p. 93)
16:00 - 16:30	Omar Kihel (Brock), *Coverable rings* (p. 88)
16:30 - 17:00	Cam Stewart (University of Waterloo), *Vecteurs de $\mathbb{C}^n$ dont les coordonnées sont multiplicativement dépendantes* (p. 91)

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10:00 - 10:30	Kumar Murty (University of Toronto), *Mumford-Tate groups of mixed motives* (p. 90)
10:30 - 11:00	Cathy Swaenepoel (Paris Diderot University), *Sommes doubles de caractères additifs sur certains ensembles structurés et applications* (p. 91)

12:30 - 13:00	Matilde Lalin (Montréal), *Non annulation des fonctions L cubiques sur les corps de fonctions* (p. 89)
13:00 - 13:30	Olivier Mila (CRM), *Triangles hyperboliques de Héron et courbes elliptiques* (p. 90)
13:30 - 14:00	Julie Desjardins (Toronto), *Constance du signe dans des familles de courbes elliptiques* (p. 87)
14:00 - 14:30	Alexander Mangerel (CRM), *Fonctions additives dans les intervalles courts et applications* (p. 90)
16:00 - 16:30	Dimitris Koukoulopoulos (Montreal), *Irréductibilité de polynômes aléatoires de grand degré* (p. 89)
16:30 - 17:00	Jean-Marie DeKoninck (Laval), *La construction de nombres normaux via la factorisation des entiers* (p. 86)
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Abstracts/Résumés

HUGO CHAPDELAINE, Université Laval
[Monday June 7 / lundi 7 juin, 17:00]
Correspondance thêta intégrale entre deux fonctions de Green λ-résolvante

Soit F un corps quadratique réel et $\{\infty_1, \infty_2\}$ ses deux places réelles. Soit $B_1/F, B_2/F$ deux algèbres de quaternions sur F. On supposera que B_1 est non-ramifiée partout (donc $B_1 \simeq M_2(F)$) et que B_2 est ramifiée exactement en les deux places $\{\infty_1, w\}$ où w est une place finie de F. Soit $O_i \subseteq B_i$ $(i = 1, 2)$ des ordres convenablement choisis. On peut associer à O_i un couple (V_i, Δ_i) où V_i est un espace vectoriel de Hilbert de fonctions automorphes et Δ_i est un opérateur de type Laplacien agissant sur V_i (non-borné et essentiellement auto-adjoint). La résolvante de l'opérateur Δ_i, à savoir $(\Delta_i - \lambda)^{-1}$, peut être écrite comme une intégrale dont le noyau est donné par une fonction de Green automorphe G^i_λ. Dans cet exposé nous présenterons une égalité entre deux intégrales où le membre de gauche fait intervenir G^1_λ alors que membre de droite fait intervenir G^2_λ. Par la suite, nous esquisserons comment il est possible de développer les intégrales de chaque côté de cette égalité afin d'obtenir certaines " identités automorphes " qui semblent a priori non-triviales. Notons que l'origine de ce projet tire en grande partie sa source dans la célèbre correspondance de Jacquet-Langlands publiée en 1970.

CHANTAL DAVID, Université Concordia
[Tuesday June 8 / mardi 8 juin, 10:00]
Sommes de 2 carrés successives dans les progressions arithmétiques

L'étude des entiers qui s'écrivent comme la somme de 2 carrés a été initiée par Landau et Ramanujan. En général, on s'attend à ce que les ensembles d'entiers avec des contraintes multiplicatives raisonnables, comme les premiers et les sommes de 2 carrés, soient bien distribués, dans les progressions arithmétiques et les petits intervalles. Nous étudions dans cet exposé les sommes de 2 carrés **successives** dans les progressions arithmetiques. Si on note par E_n le n-ième entier qui est la somme de 2 carrés, alors on veut compter les entiers $E_n \leq x$ tels que $E_n \equiv a \mod q$ et $E_{n+1} \equiv b \mod q$, pour un module q et une paire de classes (a, b) fixés. Les modèles probabilistes prédisent que chaque paire de classes (a, b) contient le même nombre de sommes de 2 carrés (asymptotiquement), mais les données numériques présentent de larges fluctuations entre les classes (a, b), en particulier quand $b - a \equiv 0 \mod q$.

En se basant sur les travaux de Lemke Oliver et Soundararajan, qui on étudié le cas des premiers successifs dans les progressions arithmétiques, nous présentons un modèle basé sur les conjectures de Hardy-Littlewood (pour les sommes de 2 carrés) qui explique les fluctuations entre les classes (a, b).

En collaboration avec L. Devin, J. Nam et J. Schlitt.

JEAN-MARIE DEKONINCK, Université Laval
[Thursday June 10 / jeudi 10 juin, 16:30]
La construction de nombres normaux via la factorisation des entiers

Étant donné un entier $q \geq 2$, on dit qu'un nombre irrationnel est un $nombre\ q\text{-}normal$ si, lorsqu'on examine son écriture en base q, on constate que toute séquence de k chiffres y figurant apparait avec une fréquence de $1/q^k$. Nous allons montrer comment on peut exploiter le chaos et la régularité inhérents à la factorisation des entiers pour créer de grandes familles de nombres normaux. Ceci est un travail conjoint avec Imre Kátai.

LASSINA DEMBÉLÉ, Université du Luxembourg
[Tuesday June 8 / mardi 8 juin, 13:00]
Calcul des traces des opérateurs de Hecke sur les groupes orthogonaux

Dans cet exposé, nous allons décrire une approche qui nous permet de calculer les opérateurs de Hecke sur des groupes orthogonaux de rang moyen.

JULIE DESJARDINS, University of Toronto
[Thursday June 10 / jeudi 10 juin, 13:30]
Constance du signe dans des familles de courbes elliptiques

Le signe $W(E) \in \{\pm 1\}$ ("root number" en anglais) d'une courbe elliptique sur $\mathbb{Q}$ est un substitut pratique au rang géométrique $r(E)$. Ces quantités sont conjecturalement reliées par la conjecture de parité $W(E) = (-1)^{r(E)}$. Dans ma thèse, j'ai démontré que le signe prend chaque valeur possible, $+1$ ou -1, pour une infinité de fibres dans une famille non-isotriviale de courbes elliptiques. Toutefois, si l'on se restreint aux "fibres entières", la situation change, et l'on peut trouver des familles dont le signe est constant, par exemple celle de Washington $y^2 = x^3 + tx^2 - (t-3)x + 1$, où le signe est toujours -1. Pour ce même exemple, il est démontré numériquement que le rang est 1 si $|t| < 1000$. Dans un projet avec R. Chu, nous identifions ces familles non isotriviales de courbes elliptiques données par une équation de Weierstrass avec des coefficients de petits degrés (≥ 2) et dont le signe est le même pour toutes les fibres entières.

LUCILE DEVIN, Chalmers - Université de Göteborg
[Tuesday June 8 / mardi 8 juin, 10:30]
Biais de Chebyshev et sommes de deux carrés

Après une étude des termes secondaires dans le Théorème des Nombres Premiers en Progression Arithmétique, Chebyshev a affirmé qu'il y a plus de nombres premiers congrus à 3 modulo 4 qu'à 1 modulo 4. Cette affirmations a été expliquée Rubinstein et Sarnak. Nous verrons comment leurs idées peuvent s'adapter à d'autres questions liées à la répartition des nombres premiers. Nous illustrerons cela par une nouvelle affirmation à la Chebyshev : "en général" plus que la moitié des nombres premiers qui peuvent s'écrire comme une somme de deux carrés ont le carré impair qui est le carré d'un nombre positif congru à 1 modulo 4.

ANDREW GRANVILLE, U de M
[Thursday June 10 / jeudi 10 juin, 17:00]
Les points rationelles sur une courbe planaire de degre D

Etant donne une courbe planaire C, on demande pour quelle entiers d, est-ce qu'il y a des points rationelles sur la courbe, ou les points genere un corps de degree d ? Il ya beaucoup de structure dans l'ensemble des d, et nous esperons de le comprendre bien avant mon conference !

C'est un travaille joint avec Lea Beneish.

ALIA HAMIEH, UNBC
[Tuesday June 8 / mardi 8 juin, 17:00]
Mean Values of Long Dirichlet Polynomials with Higher Divisor Coefficients

Assuming a conjectural formula for a certain family of additive divisor sums, we prove an asymptotic formula for mean values of long Dirichlet polynomials with higher order shifted divisor functions as coefficients. This establishes a conjecture of Coney-Keating under the assumption of an additive divisor conjecture. As a consequence, we prove a special case of a conjecture of Conrey-Gonek when the additive divisor conjecture is known. This is joint work with Nathan Ng.

FLORIAN HERZIG, University of Toronto
[Monday June 7 / lundi 7 juin, 16:00]
Sur le programme de Langlands modulo p

La correspondance de Langlands "classique" (sur $\mathbb{C}$) apparaît naturellement dans la cohomologie des variétés de Shimura. On considère l'analogue modulo p, donc sur un corps de caractéristique p, pour le groupe GL_2 sur une extension non-ramifiée K de $\mathbb{Q}_p$ (localement en p). On obtient de nouveaux résultats sur la taille (dimension de Gelfand-Kirillov) et la structure de la représentation de $\mathrm{GL}_2(K)$ qui apparaît dans la cohomologie pour une représentation galoisienne automorphe donnée. Il s'agit d'un travail en commun avec Christophe Breuil, Yongquan Hu, Stefano Morra et Benjamin Schraen.

HABIBA KADIRI, University of Lethbridge
[Tuesday June 8 / mardi 8 juin, 16:30]
Ideaux premiers dans le théorème de densité de Chebotarev pour tous les corps de nombres

Soit une extension galoisienne L/K de corps de nombres, telle que $L \neq \mathbb{Q}$, et soit C une classe de conjugaison du groupe de Galois de L/K. Nous montrons qu'il existe un idéal premier $\mathfrak{p}$, non ramifié dans L, tel que $\sigma_{\mathfrak{p}} = C$ et tel que $N\mathfrak{p} \leq d_L^B$, où $B = 310$. Ceci améliore un résultat précédent d'Ahn et Kwon où $B = 12\,577$. Ici l'outil principal est un phénomène de Deuring-Heilbronn (de répulsion des zéros de la fonction zeta de Dedekind) plus accentué. Nous utilisons également des vérifications numériques de Fiori pour une liste finie de corps de nombres.

Il s'agit d'un travail conjoint avec Peng-Jie Wong (NCTS, Taiwan).

OMAR KIHEL, Brock University
[Wednesday June 9 / mercredi 9 juin, 16:00]
Coverable rings

It is a well-known result that a group cannot be the union of two of its proper subgroups. Scorza seems to have been the first to show that a group is a union of three of its proper subgroups if and only if it has a quotient isomorphic to the Klein 4-group $V = {C_2}^2$. Similar results exist for coverings by four, five, and six proper subgroups, where V is replaced with another finite group in each case. Consideration of a covering by seven proper subgroups yields a result akin to the two proper subgroups case: no group can be written as a union of seven of its proper subgroups.

Few authors have considered to problem of covering a ring by its proper subrings. We say that a ring R is coverable if R is equal to a union of its proper subrings. If this can be done using a finite number of proper subrings, then $\sigma(R)$ denotes the *covering number* of R, which is the minimum number of subrings required to cover R. We set $\sigma(R) = 0$ if R is not coverable, and we set $\sigma(R) = \infty$ if R is coverable but not by a finite number of proper subrings.

Werner worked toward determining when it is possible to cover a ring with proper subrings and completely solved this problem for finite semisimple rings.

In this talk, among other results, we will further explore this concept of coverable rings

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DIMITRIS KOUKOULOPOULOS, Université de Montréal
[Thursday June 10 / jeudi 10 juin, 16:00]
Irréductibilité de polynômes aléatoires de grand degré

Considérons un polynôme unitaire aléatoire $f(x) = a_0 + a_1 x + \cdots + a_{n-1}x^{n-1} + x^n$, où a_j est choisi uniformément au hasard parmi 0 et 1, et indépendamment des autres coefficients. Odlyzko et Poonen ont conjecturé en 1993 que $f(x)$ est irréductible avec probabilité $\sim 1/2$ quand $n \to \infty$. Breuillard et Varjú ont prouvé cette conjecture sous l'hypothèse de Riemann généralisée. Dans cet exposé, je présenterai un travail conjoint récent avec Bary-Soroker et Kozma qui montre sans conditions que $f(x)$ est irréductible avec probabilité $\geq 1/1000$. De plus, si nous conditionnons sur l'évènement que $f(x)$ est irréductible, nous prouvons également que le groupe de Galois de $f(x)$ contient le groupe alternatif A_n avec une probabilité conditionnelle ~ 1.

Les preuves utilisent un mélange amusant d'idées issues de méthodes de crible, de l'arithmétique des polynômes sur des corps finis, de l'analyse de Fourier p-adique, des nombres premiers à chiffres restreints, de la théorie de Galois et de la théorie des groupes.

MATILDE LALIN, Université de Montréal
[Thursday June 10 / jeudi 10 juin, 12:30]
Non annulation des fonctions L cubiques sur les corps de fonctions

La conjecture de Chowla prédit que $L(1/2, \chi)$ ne s'annule pas pour les fonctions L de Dirichlet associées aux caractères primitifs χ. Elle a d'abord été conjecturée pour le cas quadratique. Pour ce cas, Soundararajan a prouvé qu'au moins $87,5\%$ des $L(1/2, \chi)$ ne s'annulent pas, en calculant les premiers moments regularisés. Pour les caractères cubiques, le premier moment a été calculé par Baier et Young (sur $\mathbb{Q}$), par Luo (pour une famille mince sur $\mathbb{Q}(\sqrt{-3})$), et par David, Florea et Lalín sur les corps de fonctions. Dans cet exposé, nous montrons qu'il existe une proportion positive de caractères de Dirichlet cubiques χ pour lesquels $L(1/2, \chi)$ ne s'annule pas dans le cas des corps de fonctions. Nous arrivons à ce résultat en calculant le premier moment regularisé en utilisant des techniques que nous avons développées précédemment dans notre travail sur le premier moment des fonctions L cubiques, et en obtenant une borne supérieure nette pour le second moment regularisé, en nous appuyant sur les travaux de Lester et Radziwill, Harper et Radziwill - Soundararajan. Nos résultats sont sur des corps de fonctions, mais avec un travail supplémentaire, ils pourraient être étendus aux champs de nombres, en supposant l'hypothèse de Riemann généralisée. Ceci est un travail en collaboration avec Chantal David et Alexandra Florea.

ANTONIO LEI, Université Laval
[Friday June 11 / vendredi 11 juin, 12:30]
Sur la sturcture algébrique du groupe de Mordell-Weil fin

Soient $E/\mathbb{Q}$ une courbe elliptique et p un nombre premier impair. Dans les années 2000's, Coates et Sujatha ont initié une étude sur le groupe de Selmer fin associé à E. Contrairement au groupe de Selmer classique, le groupe de Selmer fin nous permet d'étudier la théorie d'Iwasawa de E d'une façon uniforme, indépendamment du type de réduction de E en p. Peu après les résultats de Coates et Sujatha ont été publiés, Wuthrich a défini le groupe de Mordell-Weil fin, qui est un sous-groupe du groupe de Mordell-Weil classique et encode des informations arithmétiques sur le groupe de Selmer fin. Nous allons discuter d'un résultat sur la structure algébrique du groupe de Mordell-Weil fin. Ce résultat nous permet d'étudier un problème de Greenberg sur la structure du groupe de Selmer fin sous un angle nouveau. Si le temps le permet, nous allons discuter d'une implication de ce résultat sur les fonctions L p-adiques signées de Pollack dans le cas où E est supersingulière en p.

CLAUDE LEVESQUE, U. Laval
[Wednesday June 9 / mercredi 9 juin, 13:30]
Système fondamental d'unités d'une famille de corps de nombres de degré 12 sur $\mathbb{Q}$

Soit

$$\omega^6 = D^6 + 6D^4d + 9D^2d^2 + 2d^3 \quad \text{et} \quad \theta = \sqrt{D^2+4d}$$

avec $D \in \mathbb{N}$, $d \in \mathbb{Z}$ et $d|D$. Ici

$$\omega^6 = \alpha^6 + \beta^6 \quad \text{avec} \quad \alpha = \tfrac{1}{2}D + \tfrac{1}{2}\theta \ \text{ et } \ \beta = \tfrac{1}{2}D - \tfrac{1}{2}\theta.$$

Soit η l'unité fondamentale du corps quadratique $\mathbb{Q}(\theta)$. De concert avec H.J. Stender, nous prouvons que sous certaines hypothèses,

$$\left\{ \frac{\omega-\alpha}{\beta}, \quad \frac{\omega-\beta}{\alpha}, \quad \frac{\omega^2-\alpha^2}{\beta^2}, \quad \frac{\omega^2-\beta^2}{\alpha^2}, \quad \frac{\omega^3-\alpha^3}{\beta^3}, \quad \frac{\omega^3-\beta^3}{\alpha^3}, \quad \eta \right\}$$

est un système fondamental d'unités de $\mathbb{K} = \mathbb{Q}(\omega, \theta)$. Nous ferons quelques commentaires sur le groupe des unités de la fermeture normale $\mathbb{F}$ de $\mathbb{K}$ (de degré 24 sur $\mathbb{Q}$).

ALEXANDER MANGEREL, Centre de Recherche Mathématiques
[Thursday June 10 / jeudi 10 juin, 14:00]
Fonctions additives dans les intervalles courts et applications

La distribution des valeurs d'une fonction additive, c'est-à-dire, fonction arithmétique convenant à la propriété $g(mn) = g(m) + g(n)$ pour m, n premier entre eux, est un sujet d'intérêt classique de la théorie analytique des nombres.

Dans cet exposé nous présenterons plusieurs applications de la méthode de Matomaki et Radziwill à l'étude des sommes de fonctions additives dans les intervalles courts, ainsi que leurs conséquences portant sur le comportement local de ces fonctions.

OLIVIER MILA, Université de Montréal
[Thursday June 10 / jeudi 10 juin, 13:00]
Triangles hyperboliques de Héron et courbes elliptiques

Après un rappel sur le problème classique des triangles de Héron en géométrie euclidienne (triangles ayant aire et côtés rationnels) et sa résolution à l'aide de courbes elliptiques, nous verrons comment le généraliser aux triangles hyperboliques. Une conséquence intéressante est que le problème des nombres congruents admet toujours une infinité de solutions dans le cas hyperbolique. Un travail en collaboration avec Matilde Lalìn.

KUMAR MURTY, University of Toronto and Fields Institute
[Thursday June 10 / jeudi 10 juin, 10:00]
Mumford-Tate groups of mixed motives

We study the unipotent radical of the Mumford-Tate group of a mixed motive and relate it to certain extension classes. We use this to construct motives with three weights whose Mumford-Tate group has large unipotent radical. This is joint work with Payman Eskandari.

RAM MURTY, Queen's University
[Tuesday June 8 / mardi 8 juin, 16:00]
The vanishing of L-series and the Okada space

If f is a complex-valued arithmetical function with period N, we associate the L-series

$$L(s,f) := \sum_{n=1}^{\infty} \frac{f(n)}{n^s}.$$

It is easy to see that this series converges for $\Re(s) > 1$ and admits an analytic continuation to the entire complex plane except at $s = 1$ where it has a simple pole with residue

$$\frac{1}{N}\sum_{a=1}^{N} f(a).$$

Thus, $L(1, f)$ is finite if and only if the residue is zero, which we shall assume. The Okada space consists of all such functions f for which $L(1, f) = 0$. We construct an explicit basis for this vector space. As a consequence, we are able to derive results about $\mathbb{Q}$-linear relations among special values of the digamma function at rational arguments. This is joint work with Siddhi Pathak.

MARC-HUBERT NICOLE, Université d'Aix-Marseille
[Tuesday June 8 / mardi 8 juin, 12:30]
Le programme de Kudla p-adique en basses dimensions

Cet exposé sera une introduction motivée au programme de Kudla p-adique qui sera illustré par exemples en dimension plus petite ou égale à trois.

RACHEL OLLIVIER, UBC
[Monday June 7 / lundi 7 juin, 16:30]
Une algèbre de Hecke dérivée dans le contexte du programme de Langlands

L'exploration du programme de Langlands modulo p invite naturellement à travailler à comprendre la catégorie des représentations lisses d'un groupe réductif p-adique G en caractéristique p.

Dans ce but, Peter Schneider a introduit il y a quelques années l'algèbre différentielle graduée du pro-p Iwahori de G et montré (sous certaines hypothèses) que la catégorie dérivée de ses modules différentiels est équivalente à la catégorie dérivée des représentations de G en caractéristique p.

Dans un travail en commun avec Peter Schneider, nous explorons cette algèbre différentielle graduée, ou plus particulièrement sa cohomologie. Cet exposé rendra compte de certains résultats remarquables.

ANTHONY POËLS, Université d'Ottawa
[Wednesday June 9 / mercredi 9 juin, 10:30]
Approximation rationnelle et hypersurfaces quadratiques

A chaque point de $\mathbf{R}^n$ on associe un exposant d'approximation uniforme par les points rationnels. Un problème fondamental en approximation diophantienne est alors de déterminer la valeur maximale prise par cet exposant sur les points à coordonnées linéairement indépendantes sur $\mathbf{Q}$ dans un sous-ensemble donné de $\mathbf{R}^n$. Dans une collaboration avec Damien Roy, nous répondons à cette question pour le cas d'une hypersurface Z de $\mathbf{R}^n$ définie sur $\mathbf{Q}$: l'exposant optimal ne dépend que de l'indice de Witt (sur $\mathbf{Q}$) de la forme quadratique définissant Z. En dimension $n = 2$, nous retrouvons un résultat de Roy tandis qu'en dimension supérieure cela complète des travaux récents de Kleinbock et Moshchevitin.

CAM STEWART, University of Waterloo
[Wednesday June 9 / mercredi 9 juin, 16:30]
Vecteurs de $\mathbb{C}^n$ dont les coordonnées sont multiplicativement dépendantes

Nous discutons de la distribution des vecteurs dont les coordonnées consistent de nombres algébriques de hauteur bornée et les coordonnées sont multiplicativement dépendants.

CATHY SWAENEPOEL, Université de Paris
[Thursday June 10 / jeudi 10 juin, 10:30]
Sommes doubles de caractères additifs sur certains ensembles structurés et applications

Soient C et D deux sous-ensembles du corps fini $\mathbb{F}_q$ et soit ψ un caractère additif non-trivial de $\mathbb{F}_q$. Nous verrons que si D a une "bonne structure" alors il existe un grand sous-ensemble U de D pour lequel une majoration classique de $|\sum_{(c,u)\in C\times U}\psi(cu)|$ peut être améliorée. La preuve utilise un théorème de décomposition de Roche-Newton, Shparlinski et Winterhof. Cette nouvelle majoration permet d'améliorer un de mes résultats sur la trace de produits ainsi qu'un résultat de Gyarmati et Sárközy sur une équation somme-produit (pourvu que l'un des ensembles ait une "bonne structure").

Il s'agit d'un travail en collaboration avec Arne Winterhof.

ALAIN TOGBÉ, Purdue University Northwest
[Wednesday June 9 / mercredi 9 juin, 13:00]
On Diophantine pairs

Un ensemble de m entiers positifs distincts $\{a_1,\ldots,a_m\}$ est appelé m-tuplet diophantien si chaque a_ia_j+1 avec $i\neq j$ est un carré parfait. En général, soit n un entier, un ensemble de m entiers positifs $\{a_1,\ldots,a_m\}$ est appelé un m-tuplet diophantien avec la propriété $D(n)$ si chaque a_ia_j+n avec $i\neq j$ est un carré parfait. Diophante a étudié des ensembles de nombres rationnels positifs avec cette propriété, en particulier il a trouvé l'ensemble $\{\frac{1}{16},\frac{33}{16},\frac{17}{4},\frac{105}{16}\}$. Mais le premier quadruple diophantien a été découvert par Fermat. C'est l'ensemble $\{1,3,8,120\}$. De plus, Baker et Davenport ont prouvé que l'ensemble $\{1,3,8,120\}$ ne peut pas être étendu à un quintuple diophantien. Le problème de l'extensibilité des m-tuplets diophantiens est d'un grand intérêt.

Pour la première partie de cet exposé, nous donnerons un historique très bref des paires diophantiennes. Dans la deuxième partie, nous examinerons l'extensibilité du couple diophantien $\{a,b\}$, où $b=3a$ et prouverons qu'un tel ensemble ne peut pas être étendu à un quadruple diophantien irrégulier. Enfin, nous verrons que pour $b=8a$, on obtient un résultat similaire.

Cet exposé est basé sur un article commun avec Adédji, He et Pintér.

CHRISTELLE VINCENT, University of Vermont
[Tuesday June 8 / mardi 8 juin, 13:30]
Une banque de données sur les classes d'isogénie des variétés abéliennes sur les corps finis

Dans cet exposé, nous présentons la L-functions and modular forms database (LMFDB), une banque de données compilant les propriétés de certains objets motiviques et automorphiques, dans le but d'étoffer les connections entre ces objets lorsqu'ils sont liés (ou suspectés d'être liés) par la correspondance de Langlands. Nous allons en particulier nous concentrer sur la banque de données contenant les classes d'isogénie des variétés abéliennes sur les corps finis, que nous avons développée en collaboration avec Dupuy, Kedlaya et Roe. Nous allons présenter brièvement les mathématiques qui soutiennent cette banque de données et une conjecture que nous avons pu réfuter grâce à nos données.

PAUL VOUTIER, London
[Wednesday June 9 / mercredi 9 juin, 12:30]
Quasi-carrés dans les suite récurrentes binaires (Near-squares in binary recurrence sequences)

avec Nikos Tzanakis (with Nikos Tzanakis)

Nous disons qu'un entier est *quasi-carré* s'il est le produit d'un nombre premier et un carré. Mignotte et Pethő (1993) ont prouvé que, pour tout entier $a>3$, il n'y a aucun élément qui soit un carré, deux fois un carré ou trois fois un carré dans la suite définie par $u_0=0$, $u_1=1$ et $u_{n+2}=au_{n+1}-u_n$ pour $n\geq 0$, dès que $n>4$.

Nos travaux suggèrent un énoncé plus fort. Pour $n > 7$, il semble qu'il n'y ait aucun élément de cette suite qui soit un quasi-carré.

Pour la relation de récurrence plus générale $u_{n+2} = au_{n+1} - b^2u_n$ avec $a > b^2$, la même chose semble s'appliquer dès que $n > 13$.

Nous expliquons pourquoi cela semble être le cas. Nous présentons les résultats partiels que nous avons obtenus dans cette direction.

We say an integer is a *near-square* if it is a prime times a square. Mignotte and Pethő (1993) proved that, for all integers $a > 3$, there are no elements that are squares, two times squares or three times squares in the sequence defined by $u_0 = 0$, $u_1 = 1$ and $u_{n+2} = au_{n+1} - u_n$ for $n \geq 0$, once $n > 6$.

Our investigations suggest that something stronger is happening. For $n > 7$, it appears that there are no elements in this sequence that are near squares.

Generalising the recurrence relation to $u_{n+2} = au_{n+1} - b^2u_n$ with $a > b^2$, then the same appears to hold once $n > 13$.

We explain why this appears to be the case and give our partial results in this direction.

MICHEL WALDSCHMIDT, Sorbonne University
[Wednesday June 9 / mercredi 9 juin, 10:00]
interpolation de fonctions en un nombre fini de points avec certaines dérivées

Le développement de Taylor montre l'existence (sous certaines conditions nécessaires et suffisantes) et l'unicité d'une fonction ayant des dérivées prenant des valeurs données en un point. Dans cet exposé, on présente des variantes consistant à prendre plusieurs points au lieu d'un seul, et certaines dérivées au lieu de toutes. L'exemple le plus connu est celui de deux points et les dérivées d'ordre pair. Comme application arithmétique, on étudie ce qui se passe quand les dérivées en question sont des nombres entiers: le cas d'un seul point et de toutes les dérivées correspond à ce qui est appelé les fonctions de Hurwitz.

ALED WALKER, Trinity College Cambridge
[Tuesday June 8 / mardi 8 juin, 14:00]
Problèmes extrémaux pour les plus grands diviseurs communs

Dans cet exposé nous discuterons du lien entre les ideés de Koukoulopoulos et Maynard, de leur demonstration d'une vielle conjecture en approximation diophantienne, et des questions subtiles en théorie combinatoire des nombres. Ces questions portent sur la taille maximale de deux ensembles finis de nombres naturels A et B avec la propriété que 1

GARY WALSH, Tutte Institute & Ottawa
[Wednesday June 9 / mercredi 9 juin, 14:00]
Computing Power Integral Bases of Pure Quartic Fields

Istvan Gaal et Laszlo Remete ont déterminé les petites solutions intégrales des équations de Thue quartiques binaires de la forme $x^4 - dy^4 = \pm 1$, et ont utilisé leurs résultats pour déterminer des korps de nombres quartiques de discriminant jusqu'à 10^7 qui contiennent une base d'intégrale de puissance. Dans notre exposé, nous proposons une nouvelle façon d'aborder ce problème diophantienne, et nous montrons également comment une version efficace de la conjecture abc permettrait des améliorations considérables. Il s'agit d'un travail conjoint avec Michael Bennett.

Istvan Gaal and Laszlo Remete determined the small integral solutions to binary quartic Thue equations of the form $x^4 - dy^4 = \pm 1$, and used their results to determine pure quartic number fields of discriminant up to 10^7 which contain a power integral basis. In our talk, we propose a new way to approach this Diophantine problem, and we also show how an effective version of the abc conjecture would allow for considerable improvements. This is joint work with Michael Bennett.

Anything but Calculus! Alternatives to teaching Calculus in year 1
Les alternatives à l'enseignement du calcul en première année

Org: Andie Burazin (Toronto), **Lauren Dedieu** (Calgary) and/et **Miroslav Lovric** (McMaster)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
16:05 - 16:30	Conrad Wolfram (Wolfram Research), *Will mainstream maths education survive the AI age?* (p. 96)
16:30 - 16:55	Chris Sangwin (University of Edinburgh), *Product vs process: problem solving as a year one activity.* (p. 95)
16:55 - 17:20	Chris Rasmussen (San Diego State University), *Dynamical Systems Instead of Calculus* (p. 95)
17:20 - 17:45	Wes Maciejewski (San José State University), *Life After Calculus* (p. 94)
17:45 - 18:00	Open discussion on Monday

Wednesday June 9	**mercredi 9 juin**
12:35 - 13:00	Peter Taylor (Queens University), *Reinventing Calculus* (p. 95)
13:00 - 13:25	Deborah Hughes Hallett (Harvard Kennedy School), *When Should Students Learn About Data? Now!* (p. 94)
13:25 - 13:50	Claus Michelsen (University of Southern Denmark), *From a discipline-oriented year 1 to an interdisciplinary mathematical modeling course* (p. 95)
13:50 - 14:15	Marc De Benedetti (University of Toronto), *Should First-Year Calculus be Taught by Physicists?* (p. 94)
16:00 - 17:00	Open discussion on Wednesday

Abstracts/Résumés

MARC DE BENEDETTI, University of Toronto
[Wednesday June 9 / mercredi 9 juin, 13:50]
Should First-Year Calculus be Taught by Physicists?

How much calculus do non-math students actually need to be able to apply key concepts in real-life applications? Although a substantial amount of calculus is required to formally derive many important equations in science-based disciplines (e.g. equations of motion or population dynamics), is there a way to obtain many of these results by an exercise in critical thinking? Alternative topics that should be considered for such a first-year service calculus/math course will be discussed from the viewpoint of a physicist in the context of some selected examples to demonstrate how critical analysis can be used to obtain the answer without the use of advanced mathematics.

DEBORAH HUGHES HALLETT
[Wednesday June 9 / mercredi 9 juin, 13:00]
When Should Students Learn About Data? Now!

The world outside universities is using more and more data. Many of our students want to know about AI, big data, and machine learning—and some will go on to be successful in these fields. Let's think about how we can include working with data in as many courses as possible—inside and outside mathematics. Does data provide interesting examples? We will talk about the benefits—and challenges—of using data, with examples from the pandemic, sustainability, and climate change.

WES MACIEJEWSKI, San José State University
[Monday June 7 / lundi 7 juin, 17:20]
Life After Calculus

Though calculus has roots stretching back throughout human history, the teaching of calculus is a relatively recent phenomenon. If we managed so long without it, is it necessarily now here to stay in perpetuity ? I argue that it isn't - that now is the time we ought to overcome calculus. This won't be easy, however, given the centrality of calculus in non-mathematics degree programs. Join me in imagining life after calculus.

CLAUS MICHELSEN, University of Southern Denmark
[Wednesday June 9 / mercredi 9 juin, 13:25]
From a discipline-oriented year 1 to an interdisciplinary mathematical modeling course

For many years the science study programmes at the University of Southern Denmark had a common first year, called the Science Year, consisting of a number of courses in calculus, physics, chemistry and biology. In connection with an extensive reform project, the Science Year was changed to consist of a course centered around project work and two large courses. One of these was the course in interdisciplinary mathematical modeling. In the presentation, I present the didactical ideas of the course, as well as how the implementation of the course was supported with a didactic model for instruction and competence development of teachers including workshops and seminars.

CHRIS RASMUSSEN, San Diego State University
[Monday June 7 / lundi 7 juin, 16:55]
Dynamical Systems Instead of Calculus

In this presentation I outline how we might forgo calculus and start with dynamical systems. This approach would build on students intuitive and everyday experience with rate of change and engage them in realistic modeling problems, from population growth to climate change. Leveraging the instructional design theory of Realistic Mathematics Education, the course would embrace qualitative, graphical, and numerical approaches and focus on underlying concepts.

CHRIS SANGWIN, University of Edinburgh
[Monday June 7 / lundi 7 juin, 16:30]
Product vs process: problem solving as a year one activity.

There are two important strands to mathematical activity. The use of routine techniques (such as calculus), and problem solving. Many university mathematics courses in early years concentrate on the systematic use of routine techniques. In this talk I describe my experience of running a problem solving class for six years. The goal of this course was not to teach specific content, such as calculus, but to give students a direct experiences of the process of mathematical discovery. Based on the Socratic method, the fundamental point of the course was for students to solve problems themselves ; to present their solutions to their peers ; and to criticize the solutions of others. The course had three 50 min sessions per week, and for the content I chose problems in elementary geometry. The subject matter is less important than giving students interesting problems, expecting them to take responsibility and providing students with an opportunity to re-submit and improve their work. The experience of this course was mostly positive, robust to a variety of different problem sets and with a range of colleagues. The obvious difficulty is that the staff time required scales linearly with student numbers in a way which does not occur with large lectures. Hence, these courses are expensive in staff time. My conclusion is not that we can't afford to teach students in this way, but that we can't afford not to teach at least one early course in this way.

PETER TAYLOR, Queen's
[Wednesday June 9 / mercredi 9 juin, 12:35]
Reinventing Calculus

The calculus reform movement goes back 40 years. While it introduced new kinds of problems, it forgot to change the "laundry list" structure of the curriculum. The result of this is too often a fragmented unimaginative curriculum that fails to prepare most of our students for the world they are entering. I will explain what I mean by "the structure of the curriculum" and will illustrate this with a couple of examples.

CONRAD WOLFRAM, Wolfram Research
[Monday June 7 / lundi 7 juin, 16:05]
Will mainstream maths education survive the AI age ?

Coming Soon

Applications of Machine Learning Algorithms to Finance
L'application des algorithmes de l'apprentissage automatique en finance

Org: Michael Chen (York University) and/et **George Lai** (Wilfrid Laurier University)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Hua Li (Zhengzhou University) (p. 98)
10:30 - 11:00	Rongda Chen (Zhejiang University of Finance and Economics) (p. 97)
12:30 - 13:00	Le Jiang (Shanghai University of Finance and Economics) (p. 97)
13:00 - 13:30	Rogemar Mamon (Western University) (p. 98)
13:30 - 14:00	Rui Liang (York University) (p. 98)
14:00 - 14:30	Teresa Cristina de Sa Lima (York University) (p. 98)
16:00 - 16:30	Frederic Godin (Concordia University) (p. 97)
16:30 - 17:00	David Xu (Ryerson University) (p. 98)

Wednesday June 9	**mercredi 9 juin**
10:00 - 10:30	Ling Zhang (Guangdong University of Finance) (p. 98)
10:30 - 11:00	Yaode Sui (Wilfrid Laurier University) (p. 98)
12:30 - 13:00	Bihai Su (Shanghai University of Finance and Economics) (p. 98)
13:00 - 13:30	Kai Liu (University of Prince Edward Island) (p. 98)
13:30 - 14:00	Anastasis Kratsios (ETH Zurich) (p. 97)
14:00 - 14:30	Richard Le (York University) (p. 97)
16:00 - 16:30	Mingfu Wang (York University) (p. 98)
16:30 - 17:00	George Lai (Wilfrid Laurier University) (p. 97)

Abstracts/Résumés

RONGDA CHEN, Zhejiang University of Finance and Economics
[Tuesday June 8 / mardi 8 juin, 10:30]

FREDERIC GODIN, Concordia University
[Tuesday June 8 / mardi 8 juin, 16:00]

ANASTASIS KRATSIOS, ETH Zurich
[Wednesday June 9 / mercredi 9 juin, 13:30]

GEORGE LAI, Wilfrid Laurier University
[Wednesday June 9 / mercredi 9 juin, 16:30]

LE JIANG, Shanghai University of Finance and Economics
[Tuesday June 8 / mardi 8 juin, 12:30]

RICHARD LE, York University
[Wednesday June 9 / mercredi 9 juin, 14:00]

HUA LI, Zhengzhou University
[Tuesday June 8 / mardi 8 juin, 10:00]

RUI LIANG, York University
[Tuesday June 8 / mardi 8 juin, 13:30]

TERESA CRISTINA DE SA LIMA, York University
[Tuesday June 8 / mardi 8 juin, 14:00]

KAI LIU, University of Prince Edward Island
[Wednesday June 9 / mercredi 9 juin, 13:00]

ROGEMAR MAMON, Western University
[Tuesday June 8 / mardi 8 juin, 13:00]

BIHAI SU, Shanghai University of Finance and Economics
[Wednesday June 9 / mercredi 9 juin, 12:30]

YAODE SUI, Wilfrid Laurier University
[Wednesday June 9 / mercredi 9 juin, 10:30]

MINGFU WANG, York University
[Wednesday June 9 / mercredi 9 juin, 16:00]

DAVID XU, Ryerson University
[Tuesday June 8 / mardi 8 juin, 16:30]

LING ZHANG, Guangdong University of Finance
[Wednesday June 9 / mercredi 9 juin, 10:00]

Applied Probability and Stochastic Processes
La probabilité appliquée et les processus stochastiques

Org: Rafal Kulik and/et **Aaron Smith** (Ottawa)

Schedule/Horaire

Tuesday June 8 — **mardi 8 juin**

12:30 - 13:00	Gennady Samorodnitsky (Cornell University), *A new shape of extremal clusters for certain stationary semi-exponential processes with moderate long range dependence* (p. 102)
13:00 - 13:30	Ahmed Sid-Ali (Carleton University), *Large-Scale and Large-Time Behaviour of Finite-State Mean-Field Interacting Particle Systems on Block-structured Networks* (p. 102)
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Abstracts/Résumés

ALEXANDRE BOUCHARD, University of British Columbia
[Wednesday June 9 / mercredi 9 juin, 14:00]
Approximation of intractable integrals using non-reversibility and non-linear distribution paths

In the first part of the talk, I will present an adaptive, non-reversible Parallel Tempering (PT) allowing MCMC exploration of challenging problems such as single cell phylogenetic trees. A sharp divide emerges in the behaviour and performance of reversible versus non-reversible PT schemes: the performance of the former eventually collapses as the number of parallel cores used increases whereas non-reversible benefits from arbitrarily many available parallel cores. These theoretical results are exploited to develop an adaptive scheme to efficiently optimize over annealing schedules.

In the second half, I will talk about the global communication barrier, a fundamental limit shared by both reversible and non-reversible PT methods, and on our recent work that leverage non-linear annealing paths to provably and practically break that barrier.

My group is also interested in making these advanced non-reversible Monte Carlo methods easily available to data scientists. To do so, we have designed a Bayesian modelling language to perform inference over arbitrary data types using non-reversible, highly parallel algorithms.

References:

- Non-Reversible Parallel Tempering: a Scalable Highly Parallel MCMC Scheme. Saifuddin Syed, Alexandre Bouchard-Côté, George Deligiannidis, Arnaud Doucet. https://arxiv.org/pdf/1905.02939.pdf

- Software: https://www.stat.ubc.ca/ bouchard/blang/

HAOSUI DUANMU, University of California, Berkeley

[Wednesday June 9 / mercredi 9 juin, 12:30]

Mixing and Hitting Times for General Markov Processes

Nonstandard analysis, a powerful machinery derived from mathematical logic, has had many applications in probability theory as well as stochastic processes. Nonstandard analysis allows construction of a single object—a hyperfinite probability space—which satisfies all the first order logical properties of a finite probability space, but which can be simultaneously viewed as a measure-theoretical probability space via the Loeb construction. As a consequence, the hyperfinite/measure duality has proven to be particularly in porting discrete results into their continuous settings.

In this talk, for every general-state-space discrete-time Markov process satisfying appropriate regularity conditions, we construct a hyperfinite Markov process which has all the basic order logical properties of a finite Markov process to represent it. We show that the mixing time and the hitting time agree with each other up to some multiplicative constants for discrete-time general-state-space reversible Markov processes satisfying certain condition, hence extending a well-known result of Yuval Peres and Perla Sousi.

PHILIP ERNST, Rice Statistics

[Wednesday June 9 / mercredi 9 juin, 16:30]

Quickest real-time detection of a Brownian coordinate drift

Consider the motion of a Brownian particle in two or more dimensions, whose coordinate processes are standard Brownian motions with zero drift initially, and then at some random/unobservable time, one of the coordinate processes gets a (known) non-zero drift permanently. Given that the position of the Brownian particle is being observed in real time, the problem is to detect the time at which a coordinate process gets the drift as accurately as possible. We solve this problem in the most uncertain scenario when the random/unobservable time is (i) exponentially distributed and (ii) independent from the initial motion without drift. The solution is expressed in terms of a stopping time that minimizes the probability of a false early detection and the expected delay of a missed late detection. To our knowledge this is the first time that such a problem has been solved exactly in the literature. This is joint work with Goran Peskir (University of Manchester).

ALEXEY KUZNETSOV, York University

[Wednesday June 9 / mercredi 9 juin, 16:00]

On ordered beta distributions and their applications

Ordered beta distribution can be constructed by taking independent beta random variables $X_1, ..., X_n$ and conditioning on the event $X_1 < X_2 < ... < X_n$. Such distributions were introduced recently in operations research literature in connection with the following two problems: (i) dynamic pricing with demand learning and (ii) finding optimal bidding policies in a name-your-own-price (NYOP) product markets. In this presentation we will first talk about the above two problems and the methods used to solve them ; then we will discuss various properties of ordered beta distributions and we will conclude by presenting two efficient numerical algorithms for working with ordered beta distributions.

FLORIAN MAIRE, Université de Montréal

[Wednesday June 9 / mercredi 9 juin, 13:30]

Weak Peskun ordering for approximate MCMC comparison

Despite the popularity of Markov chain Monte Carlo methods (MCMC) in Bayesian statistics and elsewhere, very few tools are available to establish a theoretical comparison between two (or more) competing MCMC algorithms. The Peskun ordering (Peskun, 1973) is well known for achieving this task. However, showing that a Markov kernel dominates another one (in the Peskun sense) is usually a strenuous exercise and since the Peskun ordering is only a partial ordering, two kernels need not be ordered. In this work, we propose a weaker version of the Peskun ordering which is more widely applicable and easier to establish, and this, at the price of giving only approximate comparison results. This weak Peskun ordering is applied to give elements of answers to two recent questions in the MCMC literature, namely when does a non-reversible Metropolis random walk dominate a reversible one and when does a locally-weighted Gibbs sampler dominate a random-scan Gibbs sampler.

TAKASHI OWADA, Purdue University
[Tuesday June 8 / mardi 8 juin, 17:00]
Convergence of persistence diagram in the subcritical regime

The objective of this work is to examine the asymptotic behavior of persistence diagrams associated with Čech filtration. A persistence diagram is a graphical descriptor of a topological and algebraic structure of geometric objects. We consider Čech filtration over a scaled random sample $r_n^{-1}\mathcal{X}_n = \{r_n^{-1}X_1, \ldots, r_n^{-1}X_n\}$, such that $r_n \to 0$ as $n \to \infty$. We treat persistence diagrams as a point process and establish their limit theorems in the subcritical regime: $nr_n^d \to 0$, $n \to \infty$. In this setting, we show that the asymptotics of the kth persistence diagram depends on the limit value of the sequence $n^{k+2}r_n^{d(k+1)}$. If $n^{k+2}r_n^{d(k+1)} \to \infty$, the scaled persistence diagram converges to a deterministic Radon measure almost surely in the vague metric. If r_n decays faster so that $n^{k+2}r_n^{d(k+1)} \to c \in (0, \infty)$, the persistence diagram weakly converges to a limiting point process without normalization. Finally, if $n^{k+2}r_n^{d(k+1)} \to 0$, the sequence of probability distributions of a persistence diagram should be normalized, and the resulting convergence will be treated in terms of the $\mathcal{M}_0$-topology.

ZBIGNIEW PALMOWSKI, Wroclaw University of Science and Technology
[Tuesday June 8 / mardi 8 juin, 16:30]
On the renewal theorem for maxima on trees

We consider the distributional fixed-point equation:

$$R \stackrel{\mathcal{D}}{=} Q \vee \left(\bigvee_{i=1}^{N} C_i R_i \right),$$

where the $\{R_i\}$ are i.i.d. copies of R, independent of the vector $(Q, N, \{C_i\})$, where $N \in \mathbb{N}$, $Q, \{C_i\} \geq 0$ and $P(Q > 0) > 0$. By setting $W = \log R$, $X_i = \log C_i$, $Y = \log Q$ it is equivalent to the high-order Lindley equation

$$W \stackrel{\mathcal{D}}{=} \max \left\{ Y, \max_{1 \leq i \leq N} (X_i + W_i) \right\}.$$

It is known that under Kesten assumptions,

$$P(W > t) \sim He^{-\alpha t}, \qquad t \to \infty,$$

where $\alpha > 0$ solves the Cramér-Lundberg equation $E\left[\sum_{j=1}^{N} C_i^{\alpha}\right] = E\left[\sum_{i=1}^{N} e^{\alpha X_i}\right] = 1$. The main goal of this paper is to provide an explicit representation for $P(W > t)$, which can be directly connected to the underlying weighted branching process where W is constructed and that can be used to construct unbiased and strongly efficient estimators for all t. Furthermore, we show how this new representation can be directly analyzed using Alsmeyer's Markov renewal theorem, yielding an alternative representation for the constant H. We provide numerical examples illustrating the use of this new algorithm. This is a joint work with Bojan Basrak, Michael Conroy and Mariana Olvera-Cravioto.

TOM SALISBURY, York University
[Tuesday June 8 / mardi 8 juin, 16:00]
Random walk in degenerate random environments

Classical work on RWRE assumes uniform ellipticity of the environments, so the walker always has available the maximal number of directions to move in. But interesting questions arise when this condition is relaxed, adding an aspect of percolation to the analysis. I will describe a number of results for such models (joint with Mark Holmes [Melbourne]), including a recent shape theorem for the set of accessible sites in what is called the orthant model.

GENNADY SAMORODNITSKY, Cornell University
[Tuesday June 8 / mardi 8 juin, 12:30]
A new shape of extremal clusters for certain stationary semi-exponential processes with moderate long range dependence

Extremal clusters of stationary processes can be quite intricate if the process has long memory affecting its tails. They can become random fractals, taking the shape of the stable regenerative set for certain stationary infinitely divisible processes with subexponential tails, including both power-like tails, and certain lighter tails, of which lognormal-like tails are an example. In this work we show that if the tails of the process are even lighter, specifically semi-exponential-like tails, then a new shape of extremal clusters arises, in which each stable regenerative set supports a random panoply of varying extremes.

The talk is based on joint work with Zaoli Chen.

YI SHEN, University of Waterloo
[Tuesday June 8 / mardi 8 juin, 13:30]
Random topology in soft-thresholded Gaussian models

The soft-thresholded Gaussian model have been developed in biostatistics with applications in brain imaging. It has a Bayesian structure, and hence requires a rule to choose an appropriate prior distribution. This often means choosing the height of the threshold according to known information, for example, the number of active areas, which corresponds to the number of connected components of the excursion set above the threshold. In this talk we discuss the recent results that we obtained concerning the distribution of such a number. More precisely, for certain Gaussian random fields, when the threshold tends to infinity and the searching area expands with a matching speed, both the location of the excursion sets and the location of the local maxima above the threshold will converge weakly to a Poisson point process. We will further discuss the possibility to approximate these locations when the threshold is high but not extremely high, by studying the local behavior of the critical points above the threshold of the random field. This work provides theoretical support to predict the number of active areas in the brain when using a particular threshold. This is a joint work with Jian Kang, Paul Marriott and Weinan Qi.

AHMED SID-ALI, Carleton University
[Tuesday June 8 / mardi 8 juin, 13:00]
Large-Scale and Large-Time Behaviour of Finite-State Mean-Field Interacting Particle Systems on Block-structured Networks

Since *Kac*'s and *McKean*'s seminal works, the *mean-field theory* has been widely exploited to study the time evolution of large stochastic interacting particle systems. In the classical homogeneous setting with complete interaction graphs, the big picture is well understood, and various asymptotic results have been established. Though such assumptions are reasonable in statistical physics, it might no longer be the case when considering other applications. Therefore, it is of interest to study systems where the homogeneity and/or the complete interaction assumption are no more relevant. In this talk, we take one direction towards heterogeneity by considering systems in a multi-population paradigm. Namely, we present a model for block-structured networks with dynamically changing multi-colors nodes where the interactions are described through *local empirical measures*. Two levels of heterogeneity are considered: between and within the blocks. We then look at the large-scale and large-time asymptotics of the system. We first present, under original regularity conditions, a bunch of limiting results in the $N \to \infty$ asymptotics:

Propagation of chaos, laws of large numbers, and *large deviation principles* for the vectors of empirical measures and the empirical processes together with the LDP of the corresponding unique invariant measure. We will then see how to exploit the latter results to investigate the large-time behavior of the empirical process vector by relying on the *Freidlin-Wentzell theory* and the work of Hwang and Sheu. In particular, we present some *metastable phenomena* arising at large N and large t when the limiting *McKean-Vlasov system* contains multiple ω*-limit sets*.

YIZAO WANG, University of Cincinnati
[Tuesday June 8 / mardi 8 juin, 14:00]
Recent advances on Karlin models

This talk presents an overview on recent developments of the so-called Karlin models, which originally were introduced as an infinite urn scheme and the distribution on the urns is with a regularly-varying tail. Driven by an underlying random partition, the Karlin models present a new type of long-range dependence for stationary processes.

The talk will briefly present several recent advances on the Karlin models, and highlight on two recent results. First, the dependence structure of the scaling limits of the Karlin models can be naturally extended to set-indexed stable (including Gaussian) random fields, including and generalizing a few well-known manifold-indexed random fields. Second, a seemingly different aggregation model is introduced and shown to have the same scaling limit as the Karlin models driven by random partitions studied earlier in the literature.

The talk is based on several joint works with Olivier Durieu, Zuopeng Fu, Gennady Samorodnitsky, Yi Shen, and Na Zhang.

QUAN ZHOU, Texas A&M University
[Wednesday June 9 / mercredi 9 juin, 13:00]
Mixing of local Metropolis-Hastings algorithms for variable selection

Yang et al. (2016) proved that the symmetric random walk Metropolis-Hastings algorithm for Bayesian variable selection is rapidly mixing under mild high-dimensional assumptions. In this work, we introduce a novel Metropolis-Hastings algorithm, which still proposes new states via add-delete-swap moves but has a much faster mixing time independent of the number of covariates. The key idea is to use a locally informed proposal scheme with bounded weights. Motivated by the theoretical analysis of our algorithm, we further propose a method called "two-stage drift condition" for studying convergence rates of Markov chains on general state spaces. Joint work with J. Yang, D. Vats, G. Roberts and J. Rosenthal.

Arithmetic Geometry
Géométrie arithmétique

Org: Eyal Goren (McGill) and/et **Steve Kudla** (Toronto)

Schedule/Horaire

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13:00 - 13:30	Lennart Gehrmann (University of Duisburg-Essen), *On quaternionic rigid meromorphic cocyles* (p. 106)
13:30 - 14:00	Alice Pozzi (Imperial College London), *Derivatives of Hida families and rigid meromorphic cocycles* (p. 107)
14:00 - 14:30	Mathilde Gerbelli-Gauthier (University of Chicago), *Growth of Cohomology of Arithmetic Groups and Endoscopy* (p. 106)
16:00 - 16:30	Lea Beneish (Emory University), *Fields generated by points on superelliptic curves* (p. 105)
16:30 - 17:00	Qirui Li (University of Toronto), *Linear Arithmetic Fundamental Lemma and Intersection numbers for CM cycles on Lubin—Tate spaces* (p. 106)
17:00 - 17:30	Michael Lipnowski (McGill University), *Some new computations with arithmetic groups* (p. 106)
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13:00 - 13:30	Francesc Castella (University of California, Santa Barbara), *Iwasawa theory for* $\mathrm{GL}_2 \times \mathrm{GL}_2$ *and diagonal cycles* (p. 105)
13:30 - 14:00	Luca Candelori (Wayne State University), *Topological Hecke Operators* (p. 105)
14:00 - 14:30	Ila Varma (University of Toronto), *Malle's Conjecture for octic* D_4*-fields* (p. 108)
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13:00 - 13:30	Tonghai Yang (University of Wisconsin, Madison), *Kudla-Rapoport conjecture at a ramified prime* (p. 108)
13:30 - 14:00	Siddarth Sankaran (University of Manitoba), *Arithmetic special cycles and Jacobi forms* (p. 108)
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16:00 - 16:30	Patrick Allen (McGill University), *Modularity of some PGL(2,5) representations* (p. 104)
16:30 - 17:30	Samit Dasgupta (Duke University), *On the Brumer-Stark Conjecture and Refinements* (p. 105)

Abstracts/Résumés

PATRICK ALLEN, McGill University
[Thursday June 10 / jeudi 10 juin, 16:00]
Modularity of some PGL(2,5) representations

Serre's conjecture, proved by Khare and Wintenberger, states that every odd two dimensional mod p representation of the absolute Galois group of the rationals comes from a modular form. This admits a natural generalization to totally real fields,

but even the real quadratic case seems completely out of reach. I'll discuss some of the difficulties one encounters and then discuss some new cases that can be proved when p = 5. This is joint work with Chandrashekhar Khare and Jack Thorne.

LEA BENEISH, McGill University
[Tuesday June 8 / mardi 8 juin, 16:00]
Fields generated by points on superelliptic curves

We give an asymptotic lower bound on the number of field extensions generated by algebraic points on superelliptic curves over $\mathbb{Q}$ with fixed degree n, discriminant bounded by X, and Galois closure S_n. For C a fixed curve given by an affine equation $y^m = f(x)$ where $m \geq 2$ and deg $f(x) = d \geq m$, we find that for all degrees n divisible by gcd(m, d) and sufficiently large, the number of such fields is asymptotically bounded below by X^{c_n}, where $c_n \to 1/m^2$ as $n \to \infty$. This bound is determined explicitly by parameterizing x and y by rational functions, counting specializations, and accounting for multiplicity. We then give geometric heuristics suggesting that for n not divisible by gcd(m, d), degree n points may be less abundant than those for which n is divisible by gcd(m, d). Namely, we discuss the obvious geometric sources from which we expect to find points on C and discuss the relationship between these sources and our parametrization. When one a priori has a point on C of degree not divisible by gcd(m, d), we argue that a similar counting argument applies. This talk is based on joint work with Christopher Keyes.

LUCA CANDELORI, Wayne State University
[Wednesday June 9 / mercredi 9 juin, 13:30]
Topological Hecke Operators

Topological Hecke operators were first defined by Baker in the 1980s as stable operations on elliptic homology, coinciding with the classical level one Hecke operators when evaluated on the one-point space. Very few calculations have been done with them since. In this talk, we provide the foundations for a study of eigenforms for the action of topological Hecke operators acting on the holomorphic elliptic homology of various topological spaces. We prove a multiplicity one theorem for some classes of topological spaces, and we give examples of finite CW-complexes for which multiplicity one fails. We also develop some abstract "derived eigentheory" whose motivating examples arise from the failure of classical Hecke operators to commute with multiplication by various Eisenstein series. Part of this "derived eigentheory" is an identification of certain derived Hecke eigenforms as the obstructions to extending topological Hecke eigenforms from the top cell of a CW-complex to the rest of the CW-complex. Using these obstruction classes together with our multiplicity one theorem, we calculate the topological Hecke eigenforms explicitly, in terms of pairs of classical modular forms, on all 2-cell CW complexes obtained by coning off an element in $\pi_n(S^m)$ which stably has Adams-Novikov filtration 1. These explicit examples provide a surprising connection between torsion in the stable homotopy groups of spheres and congruences between the coefficients of level one modular forms.

FRANCESC CASTELLA, University of California, Santa Barbara
[Wednesday June 9 / mercredi 9 juin, 13:00]
Iwasawa theory for $\mathrm{GL}_2 \times \mathrm{GL}_2$ and diagonal cycles

In this talk I will explain the construction, in joint work with Raul Alonso Rodriguez and Oscar Rivero, of an anticyclotomic Euler system for the tensor product of the Galois representations attached to two modular forms arising from generalized Gross–Kudla–Schoen diagonal cycles and their variation in p-adic families. As applications of this construction, we prove new cases of the Bloch–Kato conjecture in analytic rank zero and a divisibility towards an Iwasawa main conjecture.

SAMIT DASGUPTA, Duke University
[Thursday June 10 / jeudi 10 juin, 16:30]
On the Brumer-Stark Conjecture and Refinements

We will present recent results on the Brumer-Stark conjecture and refinements, with applications to explicit class field theory for totally real fields. This is joint work with Mahesh Kakde, Jesse Silliman, and Jiuya Wang.

LENNART GEHRMANN, Universität Duisburg-Essen
[Tuesday June 8 / mardi 8 juin, 13:00]
On quaternionic rigid meromorphic cocyles

Recently, Darmon and Vonk initiated the theory of rigid meromorphic cocycles for the group $\mathrm{SL}_2(\mathbb{Z}[1/p])$. One of their first major results is the algebraicity of the divisor associated to such a cocycle. Their proof does not easily generalize to more general situations as it relies on rather explicit methods. In particular, it involves computations with generators of the group $\mathrm{SL}_2(\mathbb{Z})$.

I will explain an alternative proof of their result that only uses standard homological properties of arithmetic groups, e.g. Bieri-Eckmann duality. An advantage of this approach is that it also works for $\mathfrak{p}$-arithmetic subgroups of inner forms of SL_2 over arbitrary number fields.

MATHILDE GERBELLI-GAUTHIER, Institute for Advanced Study
[Tuesday June 8 / mardi 8 juin, 14:00]
Growth of Cohomology of Arithmetic Groups and Endoscopy

I will discuss growth of Betti numbers in towers of Shimura varieties associated to unitary groups. Specifically, I will outline a strategy to bound the growth for low degrees of cohomology using automorphic representations and the phenomenon of endoscopy.

QIRUI LI, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:30]
Linear Arithmetic Fundamental Lemma and Intersection numbers for CM cycles on Lubin—Tate spaces

The Guo-Jacquet Fundamental Lemma is a higher dimensional generalization of the local field analogue of the Waldspurger formula. It has an arithmetic generalization called the Linear Arithmetic Fundamental Lemma. It is conjectured by Wei Zhang interpreting the derivative of certain orbital integral into certain intersection number of Lubin-Tate spaces, which is a local analogue of the Gross-Zagier formula. We will introduce the known results for the linear Arithmetic Fundamental Lemma, and the intersection number formula for Lubin—Tate spaces. After a joint work with Ben Howard, we also discovered a bi-quadratic generalization of the conjecture.

MICHAEL LIPNOWSKI, McGill University
[Tuesday June 8 / mardi 8 juin, 17:00]
Some new computations with arithmetic groups

We'll describe some new computations with arithmetic groups.

ZHENG LIU, University of California, Santa Barbara
[Thursday June 10 / jeudi 10 juin, 12:30]
The doubling archimedean zeta integrals for unitary groups

In order to construct p-adic L-functions for symplectic and unitary groups by using the doubling method and verify the interpolation properties predicted by the conjecture of Coates–Perrin-Riou, special archimedean test sections need to be chosen and a doubling archimedean zeta integral needs to be calculated for holomorphic discrete series. When the holomorphic

discrete series is of scalar weight, it has been done by Bocherer-Schmidt and Shimura. In this talk, I will discuss computing the archimedean zeta integrals for unitary groups when the holomorphic discrete series is of general weight. This is a joint work with Ellen Eischen.

MATTEO LONGO, Università di Padova
[Wednesday June 9 / mercredi 9 juin, 12:30]
On the Equivariant Tamagawa Number conjecture for modular forms

The Equivariant Tamagawa Number Conjecture was formulated by Bloch and Kato in 1990, and can be seen as a generalisation to motives of the Birch and Swinnerton-Dyer Conjecture for elliptic curves. In the latter case, the validity of the p-part of the Birch and Swinnerton-Dyer Conjecture for ordinary primes p is known when the analytic rank of the rational elliptic curve $E/\mathbb{Q}$ is equal to 1. We prove a similar result for the p-part of the Bloch-Kato conjecture for motives attached to newforms. For this, we prove a version of Kolyvagin's Conjecture for modular forms, from which we deduce the p-part of the Tamagawa Number Conjecture. This is a work in collaboration with Stefano Vigni.

ALICE POZZI, Imperial College London
[Tuesday June 8 / mardi 8 juin, 13:30]
Derivatives of Hida families and rigid meromorphic cocycles

A rigid meromorphic cocycle is a class in the first cohomology of the group $\mathrm{SL}_2(\mathbb{Z}[1/p])$ acting on the non-zero rigid meromorphic functions on the Drinfeld p-adic upper half plane by Möbius transformation. Rigid meromorphic cocycles can be evaluated at points of real multiplication, and their values conjecturally lie in the ring class field of real quadratic fields, suggesting striking analogies with the classical theory of complex multiplication.

In this talk, we discuss the relation between the derivatives of certain p-adic families of Hilbert modular forms and rigid meromorphic cocycles. We explain how the study of congruences between cuspidal and Eisenstein families allows us to show the algebraicity of the values of a certain rigid meromorphic cocycle at real multiplication points.

This is joint work with Henri Darmon and Jan Vonk.

KARTIK PRASANNA, University of Michigan
[Wednesday June 9 / mercredi 9 juin, 16:00]
Quaternionic modular forms, cycles and L-functions

I will give an overview of some questions about algebraic cycles and L-functions in the context of quaternionic modular forms, describe some recent progress (based on joint work with Ichino) and outline some problems that still remain.

GIOVANNI ROSSO, Concordia
[Thursday June 10 / jeudi 10 juin, 14:00]
Specialness for non-archimedean varieties

Since the fundamental work of Faltings on Mordell's conjecture, many conjectures have been made concerning the problems of when rational points of a variety over a number field are (potentially) Zariski dense. Varieties whose rational points are (potentially) Zariski dense are called special, and Campana characterised these varieties as the ones that (loosely speaking) don't admit fibrations to varieties of general type. Conjecturally, this is equivalent to the fact that complex analytification of the variety is Brody-special ; that is, it admits a dense entire curve. Inspired by the notion of Brody-special, in a joint work with Jackson Morrow, we introduced the notion of K-analytically special varieties over an algebraically closed non archimedean field K. In this presentation, I shall explain this definition and prove several results (K-analytically special sub-varieties of semi-abelian varieties are translate of semi-abelian varieties ; K-analytically special varieties don't dominate pseudo-K-analytically

Brody hyperbolic variety) that support the fact that our notion is the right one to test specialness in p-adic analytic geometry.

SIDDARTH SANKARAN, University of Manitoba
[Thursday June 10 / jeudi 10 juin, 13:30]
Arithmetic special cycles and Jacobi forms

Kudla's conjectural program predicts relations between certain (arithmetic) "special" cycles on Shimura varieties and the Fourier coefficients of automorphic forms. In this talk, I'll focus on the case of a compact orthogonal Shimura variety X ; by augmenting the special cycles with appropriate choices of Green currents, we obtain classes in the arithmetic Chow group of X (viewed as a variety over its reflex field). After reviewing these notions, I'll describe a modularity result identifying generating series built from these special cycles as Jacobi forms, yielding evidence for Kudla's conjectures in this setting.

ILA VARMA, Unviersity of Toronto
[Wednesday June 9 / mercredi 9 juin, 14:00]
Malle's Conjecture for octic D_4-fields

We consider the family of normal octic fields with Galois group D_4, ordered by their discriminant. In forthcoming joint work with Arul Shankar, we verify the strong form of Malle's conjecture for this family of number fields, obtaining the order of growth as well as the constant of proportionality. In this talk, we will discuss and review the combination of techniques from analytic number theory and geometry-of-numbers methods used to prove this and related results.

JOHN VOIGHT, Dartmouth College
[Tuesday June 8 / mardi 8 juin, 17:30]
Sato-Tate groups and modularity for atypical abelian surfaces

We discuss in detail what it means for an abelian surface A over a number field to be modular, organizing conjectures and theorems that associate to A a modular form with matching L-function. The explicit description of this modular form depends on the real Galois endomorphism type of A, or equivalently on its Sato–Tate group. For A defined over the rational numbers, this description can involve classical, Bianchi, or Hilbert modular forms ; and for each possibility, we provide a genus 2 curve with small conductor from which it arises. This is joint work with Andrew Booker, Jeroen Sijsling, Andrew Sutherland, and Dan Yasaki.

JAN VONK, University of Leiden
[Tuesday June 8 / mardi 8 juin, 12:30]
Modular generating series of RM invariants

In this short talk, I will discuss some recent progress on the modularity of generating series of RM invariants that arise as special values of rigid cocycles. This provides results in the spirit of the Kudla programme, whose intrinsically p-adic nature furnishes a direct connection with class field theory. This work is joint with Henri Darmon and Alice Pozzi.

TONGHAI YANG, UW-Madison
[Thursday June 10 / jeudi 10 juin, 13:00]
Kudla-Rapoport conjecture at a ramified prime

This is a joint work with Qiao He and Yousheng Shi. One important part of the Kudla program is the so-called Arithmetic Siegel-Weil formula, which reveals some deep relation between the Fourier coefficients of some incoherent Eisenstein series

and arithmetic Heigh pairing on a Shimura variety (of unitary type (n,1) or orthogonal (n, 2)). To prove it for non-singular coefficients, it amounts to prove a local identiy—the so-called Kudla-Rapoport conjecture or local arithmetic SIegel-Weil formula— and a global counting identity (Siegel-Weil formula). Chao Li and Wei Zhang found a beautiful proof of the Kudla-Rapoport conjecture at unramified primes. In this talk, we will discuss its analogue at ramified primes when n=1, where some modification is needed. If time permits, we might describe possible generalization of this work for general n.

Combinatorial Game Theory
Théorie des jeux combinatoires

Org: Melissa Huggan (Ryerson), **Svenja Huntemann** (Concordia University of Edmonton) and/et **Richard Nowakowski** (Dalhousie)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:30	Carlos Santos (University of Lisbon & ISEL–IPL), *Impartial games with entailing moves* (p. 112)
13:30 - 14:00	Matt Ferland (University of Southern California), *Quantum Combinatorial Games: Structures and Computational Complexity* (p. 111)
16:00 - 16:30	Melissa Huggan (Ryerson University), *The Game of Flipping Coins* (p. 111)
16:30 - 17:00	Svenja Huntemann (Concordia University of Edmonton), *Counting Domineering positions* (p. 111)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:30	Aaron Siegel, *The Abstract Structure of Misère Impartial Games, Part 2* (p. 113)
13:30 - 14:00	Neil McKay (University of New Brunswick), *Which games are equalish to 0?* (p. 112)
14:00 - 14:30	Matthieu Dufour and Silvia Heubach (UQàM and California State University), *Circular Nim CN(7,4)* (p. 110)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:30	Urban Larsson (National University of Singapore), *Game values of arithmetic functions* (p. 112)
13:30 - 14:00	Rebecca Milley (Memorial University Grenfell), *P-free dead-ending misere games* (p. 112)
14:00 - 14:30	Alexander Clow (St Francis Xavier), *Red, Blue, Green Poset Games* (p. 110)

Abstracts/Résumés

ALEXANDER CLOW, St. Francis Xavier University
[Wednesday June 9 / mercredi 9 juin, 14:00]
Red, Blue, Green Poset Games

This talk examines Red, Blue, Green (partizan) poset games under normal play. Poset games are played on a poset where players take turns choosing an element of the partial order and removing every element greater than or equal to it in the ordering. The Left player can choose Blue elements (Right cannot) and the Right player can choose Red elements (while the Left cannot) and both players can choose Green elements. Red, Blue and Red, Blue, Green poset games have not seen much attention in the literature, do to most questions about Green poset games (such as CHOMP) remaining open. We focus on results that are true of all Poset games, but time allowing, FENCES, the poset game played on fences (or zig-zag posets) will be considered. This is joint work with Dr.Neil McKay.

MATTHIEU DUFOUR AND SILVIA HEUBACH, UQAM & California State University Los Angeles
[Tuesday June 8 / mardi 8 juin, 14:00]
Circular Nim CN(7,4)

Circular Nim CN(n, k) is a variation on Nim. A move consists of selecting k consecutive stacks from n stacks arranged in a circle, and then to remove at least one token (and as many as all tokens) from the selected stacks. We will briefly review known results on Circular Nim CN(n, k) for small values of n and k and for some families, and then discuss new features that have

arisen in the set of the $\mathcal{P}$-positions of CN(7,4). We will also discuss how some of these new structures appear in the sets of the $\mathcal{P}$-positions of larger games. As time permits, we will discuss aspects of the proof for the $\mathcal{P}$–positions of CN(7,4).

MATT FERLAND, University of Southern California
[Monday June 7 / lundi 7 juin, 13:30]
Quantum Combinatorial Games: Structures and Computational Complexity

Recently, a standardized framework was proposed for introducing quantum-inspired moves in mathematical games with perfect information and no chance. Going beyond individual games, we explore the tractability of quantum combinatorial games as whole, and address fundamental questions including:

Quantum Leap in Complexity: Are there polynomial-time solvable games whose quantum extensions are intractable ?

Quantum Collapses in Complexity: Are there PSPACE-complete games whose quantum extensions fall to the lower levels of the polynomial-time hierarchy ?

Quantumness Matters: How do outcome classes and strategies change under quantum moves ? Under what conditions doesn't quantumness matter ?

PSPACE Barrier for Quantum Leap: Can quantum moves launch PSPACE games into outer polynomial space

We show that quantum moves not only enrich the game structure, but also impact their computational complexity. In settling some of these basic questions, we characterize both the powers and limitations of quantum moves as well as the superposition of game configurations that they create. Our constructive proofs-both on the leap of complexity in concrete Quantum Nim and Quantum Undirected Geography and on the continuous collapses, in the quantum setting, of complexity in abstract PSPACE-complete games to each level of the polynomial-time hierarchy-illustrate the striking computational landscape over quantum games and highlight surprising turns with unexpected quantum impact. Our studies also enable us to identify several elegant open questions fundamental to quantum combinatorial game theory (QCGT).

MELISSA HUGGAN, Ryerson University
[Monday June 7 / lundi 7 juin, 16:00]
The Game of Flipping Coins

Coin flipping games have been studied for decades. In particular, Berlekamp, Conway and Guy introduced many impartial coin flipping games in their book series Winning Ways for Your Mathematical Plays. In this talk, we will explore a brief history of such combinatorial games, and then introduce a new partizan variant called Flipping Coins.

Flipping Coins is played on a row of coins, laying flat on a table. Each coin has two sides: one side is labelled by T and the other by H. Only one side is facing up for each coin. There are two players called Left and Right. On their turn, Left chooses two coins labelled T, and flips them to H. Right chooses two coins, one labelled H and the other T, as long as they appear in that order within the row, and flips them to T and H respectively. The last player to move wins. We show that the values of this game are numbers, and these are found by applying a reduction, then decomposing the position into an iterated ordinal sum. This unexpected result leads to many questions for future research.

This is joint work with Anthony Bonato and Richard J. Nowakowski.

SVENJA HUNTEMANN, Concordia University of Edmonton
[Monday June 7 / lundi 7 juin, 16:30]
Counting Domineering positions

In Domineering, two players place dominoes on a checkerboard (or parts thereof), one vertically, the other horizontally. We will demonstrate a technique to recursively determine the polynomial profile of Domineering positions on rectangular boards. The polynomial profile enumerates the positions with a fixed number of pieces from each player and can be used to determine

the total number of positions, as well as the positions when only considering strictly alternating play. We will further discuss variations of this technique for non-rectangular boards, maximal positions, and Left and Right ends.

This is joint work with Neil McKay.

URBAN LARSSON, National University of Singapore
[Wednesday June 9 / mercredi 9 juin, 12:30]
Game values of arithmetic functions

Arithmetic functions in Number Theory meet the Sprague-Grundy function from Combinatorial Game Theory. We study a variety of normal-play games induced by standard arithmetic functions, such as divisors, remainders and relatively prime numbers, and their negations. For the ruleset induced by the division algorithm, we prove that the relative Sprague-Grundy values tend to 0 with increasing heap sizes. Preprint at https://arxiv.org/pdf/2101.07608.pdf

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NEIL MCKAY, ∅
[Tuesday June 8 / mardi 8 juin, 13:30]
Which games are equalish to 0 ?

Toppling Dominoes is a game played by Black and White on a row of standing black, white, or grey dominoes. On their turn, a player chooses a domino of their colour (or a grey domino) and topples it either left or right, every domino in that direction also topples and is removed from the game. A player unable to move loses.

In an all-grey row, the game ends exactly when neither player has any available moves. Any other game could conceivably end when only a domino of the opponents colour remains. Games that always end with neither player having any available moves are called dicotic and they are equalish to 0. Though very few positions are dicotic, there are many positions equal to dicotic games ; we describe these positions. We discuss which simple games are equalish to some Toppling Dominoes position.

REBECCA MILLEY, Grenfell Campus, Memorial University of NL
[Wednesday June 9 / mercredi 9 juin, 13:30]
P-free dead-ending misere games

In recent years, misere game research has focussed on play that is restricted to a given subset or 'universe' of games. The set of dead-ending games is the most well-studied misere universe. Consider the subset of dead-ending games that are '$\mathcal{P}$-free': games with outcome $\mathcal{L}$, $\mathcal{N}$, or $\mathcal{R}$, with no followers that are previous-win. Note that $* = \{\cdot|\cdot\}$ is not $\mathcal{P}$-free. This set of games exhibits a number of algebraic properties from normal play that do not hold in misere play (even when restricted to dead-ending games). For example, a left-win game plus a left-win game is left-win, and $\mathcal{L} + \mathcal{N}$ is either $\mathcal{L}$ or $\mathcal{N}$. This talk will prove these and other properties and will discuss in-progress conjectures about the closure and invertibility of $\mathcal{P}$-free games.

CARLOS SANTOS, ISEL-IPL ;CEAFEL-University of Lisbon
[Monday June 7 / lundi 7 juin, 12:30]
Impartial games with entailing moves

Combinatorial Game Theory has also been called 'additive game theory', whenever the analysis involves sums of independent game components. Such *disjunctive sums* invoke comparison between games, which allows abstract values to be assigned to them. However, there are rulesets with *entailing moves* that break the alternating play axiom and/or restrict the other player's options within the disjunctive sum components. These situations are exemplified in the literature by a ruleset such as Nimstring, a normal play variation of the classical children's game Dots and Boxes, and Top Entails, an elegant ruleset introduced in the classical work Winning Ways, by Berlekamp Conway and Guy. Such rulesets fall outside the scope of the established normal play theory. Here, we axiomatize normal play via two new terminating games, Inf (Left wins) and -Inf (Right wins), and a more general theory is achieved. We define *affine impartial*, which extends classical impartial games, and we analyze their algebra by

extending the established Sprague-Grundy theory, with an accompanying minimum excluded rule. Solutions of Nimstring and Top Entails are given to illustrate the theory.

AARON SIEGEL

[Tuesday June 8 / mardi 8 juin, 12:30]

The Abstract Structure of Misère Impartial Games, Part 2

Combinatorial games in misère play have been the subject of increasing interest in recent years, yet much still remains unknown about the structure of misère impartial games under classical (Conway) equality. In this talk, I will discuss the abstract structure of the canonical monoid $\mathcal{M}$ of misère games. I will give a proof of Conway's theorem that $\mathcal{M}$ is cancellable ; then I will present a few new results, including a proof that $\mathcal{M}$ is "almost" torsion-free.

This talk is a follow-up to a previous talk presented at the online CGT seminar in March 2021. However, the material is mostly independent, and it is not necessary to have attended the prior talk. Some of the work presented in this talk was joint work with John Conway and Dan Hoey.

Designs and codes
Dessins et codes

Org: David Pike (Memorial) and/et **Doug Stinson** (Waterloo)

Schedule/Horaire

Thursday June 10 **jeudi 10 juin**

10:00 - 10:30	Şule Yazici (Koç University), *Embedding orthogonal partial Latin squares* (p. 119)
10:30 - 11:00	Simon Blackburn (Royal Holloway), *Locally block-avoiding orderings of points* (p. 114)
12:30 - 13:00	Andrea Burgess (UNB), *Cyclic cycle systems of complete equipartite graphs* (p. 114)
13:00 - 13:30	Don Kreher (MTU), *Steiner's problem ... Bussey's solution* (p. 116)
13:30 - 14:00	Mahsa Shirazi (University of Regina), *On a generalization of set-wise intersection of perfect matchings* (p. 118)
14:00 - 14:30	Trent Marbach (Ryerson), *Balanced equi-n-squares* (p. 116)
16:00 - 16:30	Hadi Kharaghani (Lethbridge), *The power of prime powers in the building of designs* (p. 115)
16:30 - 17:00	Thais Bardini Idalino (SFU), *Variable cover-free families* (p. 115)
17:00 - 17:30	Charlie Colbourn (ASU), *Covering Perfect Hash Families with Index Greater Than One* (p. 115)

Friday June 11 **vendredi 11 juin**

10:00 - 10:30	Sibel Özkan (Gebze Technical University), *On The Directed Hamilton-Waterloo Problem* (p. 117)
10:30 - 11:00	Maura Paterson (Birkbeck), *Reciprocally-weighted external difference families and unconditionally secure authentication* (p. 117)
12:30 - 13:00	Bill Martin (WPI), *Duelling dragons* (p. 116)
13:00 - 13:30	Sarobidy Razafimahatratra (University of Regina), *The Erdős-Ko-Rado theorem for permutation groups* (p. 118)
13:30 - 14:00	Karen Meagher (Regina), *2-Partially Intersecting Partitions* (p. 116)
15:00 - 15:30	Lucia Moura (Ottawa), *Ordered Covering Arrays and NRT-metric Covering Codes* (p. 117)
15:30 - 16:00	Ruizhong Wei (Lakehead), *On coded caching schemes* (p. 118)
16:00 - 16:30	Brett Stevens (Carleton), *The combinatorial game NOFIL played on Steiner triple systems* (p. 118)

Abstracts/Résumés

SIMON BLACKBURN, Royal Holloway University of London
[Thursday June 10 / jeudi 10 juin, 10:30]
Locally block-avoiding orderings of points

This talk is based on joint work with Tuvi Etzion, Technion.

Let n and ℓ be positive integers. Recent papers by Kreher, Stinson and Veitch have explored variants of the problem of ordering the points in a triple system (such as a Steiner triple system, directed triple system or Mendelsohn triple system) on n points so that no block occurs in a segment of ℓ consecutive entries. (Thus the ordering is locally block-avoiding.) I will describe a greedy algorithm which produces such orderings, provided n is sufficiently large when compared to ℓ. I will also talk about some related results and open problems.

Simon R. Blackburn and Tuvi Etzion, 'Block-avoiding point sequencings', *J. Combin. Des.* 29 (2021) 339-366.

ANDREA BURGESS, University of New Brunswick
[Thursday June 10 / jeudi 10 juin, 12:30]
Cyclic cycle systems of complete equipartite graphs

A *cycle system* of a graph Γ is a partition of the edges of Γ into cycles. For a graph Γ with vertex set $\mathbb{Z}_v$, we say that a cycle system $\mathcal{D}$ of Γ is *cyclic* if, for any cycle $(c_1, c_2, \ldots, c_\ell)$ of $\mathcal{D}$, we have that $(c_1+1, c_2+1, \ldots, c_\ell+1)$ is also a cycle of $\mathcal{D}$.

In this talk, we consider cycle systems of the complete multipartite graph $K_m[n]$ with m parts of size n. We determine necessary and sufficient conditions for the existence of a cyclic ℓ-cycle system of $K_m[n]$ when $2\ell \mid (m-1)n$; this is a natural case to consider, as it allows us to construct cyclic cycle systems with no short-orbit cycles.

This is joint work with Francesca Merola and Tommaso Traetta.

CHARLIE COLBOURN, Arizona State University
[Thursday June 10 / jeudi 10 juin, 17:00]
Covering Perfect Hash Families with Index Greater Than One

Given positive integers N, k, t and a prime power q, let A be an $N \times k$ array whose symbols are column vectors from $\mathbb{F}_q^t$. The entry in row r and column c of A is denoted by $\mathbf{v}_{r,c}$. Suppose that $\{\gamma_1, \ldots, \gamma_t\}$ is a set of distinct column indices. Row r is *covering* (in A) for $\{\gamma_1, \ldots, \gamma_t\}$ if the $t \times t$ matrix $[\mathbf{v}_{r,\gamma_1} \cdots \mathbf{v}_{r,\gamma_t}]$ is nonsingular over $\mathbb{F}_q$. Then A is a *covering perfect hash family*, $\mathrm{CPHF}_\lambda(N; k, q, t)$, if there are at least λ covering rows for each way to choose $\{\gamma_1, \ldots, \gamma_t\}$. When $\lambda = 1$, such CPHFs have been explored as a means to generate the smallest known covering arrays of strengths 3 through 6 having hundreds or thousands of columns, when the number of symbols is a (small) prime power. Motivated by applications that require additional coverage in testing, in this talk we explore the construction of CPHFs with $\lambda > 1$.

THAIS BARDINI IDALINO, Universidade Federal de Santa Catarina
[Thursday June 10 / jeudi 10 juin, 16:30]
Variable cover-free families

Cover-free families have been investigated under different names and as a solution to many problems related to combinatorial group testing. In this presentation, we will review some related objects and constructions found in the literature, as well as some applications in cryptography. Inspired by these applications, we introduce the notion of *variable cover-free families*, which presents variable coverage properties.

This is joint work with Lucia Moura.

HADI KHARAGHANI, University of Lethbridge
[Thursday June 10 / jeudi 10 juin, 16:00]
The power of prime powers in the building of designs

Résumé

Assuming the weight p in a weighing matrix $W(n,p)$ is a prime power, it is shown that there is a

$$W\left(\frac{p^{m+1}-1}{p-1}(n-1)+1, p^{m+1}\right)$$

for each positive integer m. The case of $n = p+1$ reduces to the balanced weighing matrices with classical parameters

$$W\left(\frac{p^{m+2}-1}{p-1}, p^{m+1}\right).$$

DON KREHER, Michigan Technological University
[Thursday June 10 / jeudi 10 juin, 13:00]
Steiner's problem ... Bussey's solution

A set-system of order N is a pair $(X, \mathcal{B})$, where X is N-element set of $points$ and $\mathcal{B}$ is a collection of subsets of X called $blocks$.

In 1852, Professor Dr. J. Steiner of Berlin, asked for which number N does there exist a set system containing no pairs that has order N and maximum block size k satisfying

1. no block properly contains another block, and

2. for all $t = 2, 3, ..., k-1$ every t-set that does not contain a block is contained in exactly one block of size $(t+1)$.

The only known solution with maximum block size at least 5 was an infinite family exhibited by W.H. Bussey from the University of Minnesota in 1914. He provides a construction for each $k \geq 5$ a set-system of order $N = 2^{k-1} - 1$ and maximum block size k satisfying Steiner's conditions. In 1984, H. Hanani, apparently unaware of Bussey's solution, gives exactly the same solution. In this talk I will discuss Bussey's solution and report on the progress that Charlie Colbourn and I have made in constructing another solution.

TRENT MARBACH, Ryerson University
[Thursday June 10 / jeudi 10 juin, 14:00]
Balanced equi-n-squares

We define a d-balanced equi-n-square $L = (l_{ij})$, for some divisor d of n, as an $n \times n$ matrix containing symbols from $\mathbb{Z}_n$ in which any symbol that occurs in a row or column, occurs exactly d times in that row or column. We show how to construct a d-balanced equi-n-square from a partition of a Latin square of order n into $d \times (n/d)$ subrectangles. In design theory, L is equivalent to a decomposition of $K_{n,n}$ into d-regular spanning subgraphs of $K_{n/d,n/d}$. We also study when L is diagonally cyclic, defined as when $l_{(i+1)(j+1)} = l_{ij} + 1$ for all $i, j \in \mathbb{Z}_n$, which corresponds to cyclic such decompositions of $K_{n,n}$ (and thus α-labellings).

We identify necessary conditions for the existence of (a) d-balanced equi-n-squares, (b) diagonally cyclic d-balanced equi-n-squares, and (c) Latin squares of order n which partition into $d \times (n/d)$ subrectangles. We prove the necessary conditions are sufficient for arbitrary fixed $d \geq 1$ when n is sufficiently large, and we resolve the existence problem completely when $d \in \{1, 2, 3\}$.

Along the way, we identify a bijection between α-labellings of d-regular bipartite graphs and, what we call, d-starters: matrices with exactly one filled cell in each top-left-to-bottom-right unbroken diagonal, and either d or 0 filled cells in each row and column. We use d-starters to construct diagonally cyclic d-balanced equi-n-squares, but this also gives new constructions of α-labellings.

BILL MARTIN, Worcester Polytechnic Institute
[Friday June 11 / vendredi 11 juin, 12:30]
Duelling dragons

This project investigates 3-class Q-antipodal association schemes and related objects. Van Dam proved in 1999 that 3-class Q-antipodal association schemes are equivalent to the linked systems of symmetric designs of Cameron (1972). Kodalen constructed new examples in 2019, exhibiting connections to equiangular lines and real mutually unbiased bases. The dual object, at the parameter level, is a 3-class P-antipodal association scheme ; such graphs are known as distance-regular antipodal covers of complete graphs, or DRACKNs. In the special case where the automorphism group contains an abelian subgroup acting regularly on the vertices, we have an explicit duality via character theory and then we are truly challenging DRACKNs to have duals. As we will explain in this talk, this is rare.

KAREN MEAGHER, University of Regina
[Friday June 11 / vendredi 11 juin, 13:30]
2-Partially Intersecting Partitions

An ℓ-partition of a set of size $n = k\ell$ can be expressed as a set of ℓ disjoint sets, $P = \{P_1, P_2, \ldots, P_\ell\}$. Further, an ℓ-partition is uniform if $|P_i| = k$ for all $i = 1, \ldots, \ell$. Two uniform ℓ-partitions $P = \{P_1, P_2, \ldots, P_\ell\}$ and $Q = \{Q_1, Q_2, \ldots, Q_\ell\}$ are said to be 2-partially intersecting if there exist an i and j such that $|P_i \cap Q_j| \geq 2$. There are many different notions of intersection for partitions, and this particular type of intersection is connected to several different problems in design theory. In this talk I will show how an algebraic approach can be used to determine the size of the largest collection of uniform ℓ-partitions of a $k\ell$-set in which any two partitions are 2-partially intersecting.

LUCIA MOURA, University of Ottawa
[Friday June 11 / vendredi 11 juin, 15:00]
Ordered Covering Arrays and NRT-metric Covering Codes

Ordered covering arrays generalize both ordered orthogonal arrays and covering arrays, which are well-studied combinatorial designs. Classical codes using the Hamming metric can be generalized to codes with a poset metric. The Niederreiter-Rosenbloom-Tsfasman (NRT) metric corresponds to posets that are the disjoint union of chains of the same size. In this talk, we discuss ordered covering arrays and their use in upper bounds for NRT-metric covering codes. This talk is based on joint work with André Guerino Castoldi, Emerson Luiz do Monte Carmelo, Daniel Panario, and Brett Stevens.

SIBEL ÖZKAN, Gebze Technical University
[Friday June 11 / vendredi 11 juin, 10:00]
On The Directed Hamilton-Waterloo Problem

Cycle decomposition is an important branch of graph decomposition problems. There are two well-known resolvable cycle decomposition problems where cycles can be partitioned into parallel classes, namely, 2-factors. One problem is the Oberwolfach problem where each 2-factor in the decomposition is isomorphic to a given 2-factor. Another problem is the Hamilton-Waterloo problem where each 2-factor can be isomorphic to one of the given two 2-factors. Both Oberwolfach and the Hamilton-Waterloo problems are mostly studied for uniform cycle factors so far.

Directed version of the Oberwolfach problem has started to gain more interest recently. Here, the decomposed graph is the complete symmetric directed graph K_v^*. Factors with uniform -directed- cycle size 3, with uniform cycle size 4, and with uniform cycle size m where $v \equiv 0(\mathrm{mod} 2m)$, m is odd with $5 \leq m \leq 49$ are among the results on this version of the problem (see [1], [2], and [3] respectively). Here we carry this directed generalization to the Hamilton-Waterloo problem and present our first results on small cycle sizes. This is joint work with Ugur Odabasi and Fatih Yetgin.

[1] Bermond J. C., Germa A., and Sotteau D. 1979, Resolvable decomposition of K_n^*, Journal of Combinatorial Theory, Series A, 26(2), 179-185.

[2] Bennett F. E., Zhang X., 1990, Resolvable Mendelsohn designs with block size 4, aequationes mathematicae, 40(1), 248-260.

[3] Burgess A., Francetic N., Sajna M., 2018, On the directed Oberwolfach Problem with equal cycle lengths: the odd case. Australas. J. Combin., 71(2), 272-292.

MAURA PATERSON, Birkbeck, University of London
[Friday June 11 / vendredi 11 juin, 10:30]
Reciprocally-weighted external difference families and unconditionally secure authentication

Let G be a finite abelian group of order n. An (n, k, λ) m-External Difference Family (EDF)is a collection of m disjoint subsets of G each of size k, with the property that each nonzero group element occurs precisely λ times as a difference between group

elements in two different subsets from the collection. These have use as Algebraic Manipulation Detection (AMD) codes that can be viewed as a special case of an authentication code, which are structures which have long been studied as a tool for authenticating the sender of a message in an unconditionally secure setting. The AMD codes arising from EDFs have the nice feature that the success probability of an adversary in the worst case is equal to the average case success probability.

It is possible to generalise the notation of an EDF to allow subsets of different sizes. However, if we wish to keep the worst case=average case property, then we need to count the number of times that group elements arise as external differences using a weighted sum. Specifically, a reciprocally-weight EDF (RWEDF) is defined to be a generalisation of an EDF in which the subsets may have different sizes, and the differences are counted with a weighting given by the reciprocal of the set sizes. In this talk I will describe a construction of an infinite families of nontrivial RWEDFs, and discuss some open problems relating to these structures.

SAROBIDY RAZAFIMAHATRATRA, University of Regina
[Friday June 11 / vendredi 11 juin, 13:00]
The Erdős-Ko-Rado theorem for permutation groups

A set of permutations $\mathcal{F}$ of a finite transitive group $G \leq Sym(\Omega)$ is *intersecting* if any two permutations in $\mathcal{F}$ agree on an element of Ω. The *intersection density* of the intersecting set $\mathcal{F} \subset G$ is the rational number $\rho(\mathcal{F}) := \frac{|\mathcal{F}|}{|G_\omega|}$, where $\omega \in \Omega$. The intersection density of the group G is the number $\rho(G) := \max\{\rho(\mathcal{F}) : \mathcal{F} \subset G \text{ is intersecting}\}$. The permutation group G is said to have the *Erdős-Ko-Rado (EKR) property* if $\rho(G) = 1$.

I will talk about some recent progress on the construction of transitive groups that do not have the EKR property. I will also present some results on the intersection density of transitive groups of certain degrees.

MAHSA SHIRAZI, University of Regina
[Thursday June 10 / jeudi 10 juin, 13:30]
On a generalization of set-wise intersection of perfect matchings

Two perfect matchings P and Q of a graph on $2k$ vertices are said to be set-wise t-intersecting if there exist edges $P_1, \cdots, P_t$ in P and $Q_1, \cdots, Q_t$ in Q such that the union of edges $P_1, \cdots, P_t$ has the same set of vertices as the union of $Q_1, \cdots, Q_t$ has. In this talk I will present an extension of the famous Erdős-Ko-Rado (EKR) Theorem to set-wise t-intersecting families of perfect matching for $t = 2$ and $t = 3$. In particular I will prove the following:

The size of the largest set of set-wise 2 and 3-intersecting perfect matchings in K_{2k} with $k \geq 6$ is $(2k-5)!!$, and $(2k-7)!!$, respectively.

BRETT STEVENS, Carleton University
[Friday June 11 / vendredi 11 juin, 16:00]
The combinatorial game NOFIL played on Steiner triple systems

We define the impartial combinatorial game NOFIL played on designs. We review some relevant combinatorial game theory. We discuss what is known about optimal play on small Steiner triple systems, exhaustively up to order 15 and for sampled STSs of orders 19, 21 and 25. We show that the complexity of determining the outcome of a game of NOFIL (possibly with moves already made) on Steiner triple systems is PSPACE-complete by reducing the combinatorial game NODE KAYLES on graphs to NOFIL using Barber et al.'s existence theorem of triangle decompositions for sufficiently large triple-divisible graphs. This is joint work with Drs. M. Huggan and S. Huntemann.

RUIZHONG WEI, Lakehead University
[Friday June 11 / vendredi 11 juin, 15:30]
On coded caching schemes

Coded caching schemes are used to reduce the network traffic during the peak time by using the local caching to store some information during the off peak time. In this talk, we will introduce two recent results about the construction of coded caching schemes.

ŞULE YAZICI, Koç University
[Thursday June 10 / jeudi 10 juin, 10:00]
Embedding orthogonal partial Latin squares

In 1960, Evans proved that a partial Latin square of order n can always be embedded in some Latin square of order t for every $t \geq 2n$ and asked if a pair of finite partial Latin squares which are orthogonal can be embedded in a pair of finite orthogonal Latin squares. It is known, that a pair of orthogonal Latin squares of order n can be embedded in a pair of orthogonal Latin squares of order t if $t \geq 3n$, the bound of $3n$ being best possible. Jenkins, considered embedding a single partial Latin square in a Latin square which has an orthogonal mate. His embedding was of order t^2. In 2014, the first constructive polynomial embedding result for a pair of orthogonal partial Latin squares was given. Recently, the work of Jenkins is generalized and it is shown that any partial Latin square can be embedded in a Latin square which has many orthogonal mates (not just one) that are mutually orthogonal. In this talk, we review results for the embedding of orthogonal partial Latin squares in orthogonal Latin squares, comparing and contrasting these with results for embedding partial Latin squares in Latin squares. We also present a new construction that uses the existence of a set of t mutually orthogonal Latin squares of order n to construct a set of $2t$ mutually orthogonal Latin squares of order n^t.

Equity Forum
Forum sur l'équité

Org: Elana Kalashnikov (Harvard) and/et **Reila Zheng** (Toronto)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
12:30 - 13:10	Edward Doolittle (First Nations University of Canada) (p. 121)
13:30 - 14:10	Pamela Brittain and Mary Reid (University of Toronto), *The intersections of math, gender and the model minority myth: Asian students' lived experiences in math schooling* (p. 120)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:10	Marni Mishna (Simon Fraser University), *Can Canadian math institutes address equity in a meaningful way ?* (p. 121)
13:30 - 14:10	Anthony Bonato (Ryerson), *LGBTQ+ inclusion/exclusion in mathematics: why I should not have to be giving this talk* (p. 120)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:10	Israel Ncube (Alabama A&M University), *Reflections on impediments to equity, diversity, and inclusion in the mathematics professoriate* (p. 121)
13:20 - 13:40	Alexandra Wesolek, Danielle Rogers (Simon Fraser University), *Student project: Women Speaker Series* (p. 121)
13:45 - 14:25	Hermie Monterde (University of Manitoba), *A Transgender Woman's Dilemma* (p. 121)

Abstracts/Résumés

ANTHONY BONATO, Ryerson University
[Wednesday June 9 / mercredi 9 juin, 13:30]
LGBTQ+ inclusion/exclusion in mathematics: why I should not have to be giving this talk

Mathematics should be a safe space for all, but it hasn't been. Even today, we don't see representation from all groups in mathematics, especially from those who are BIPOC or LGBTQ+.

When LGBTQ+ mathematicians talk about inclusion in mathematics and in society, they put themselves in the uncomfortable and potentially unsafe situation of advocating for their own rights and freedoms. Refracted through my own experience, I'll discuss the intersectional challenges facing LGBTQ+ mathematicians, opportunities for action, and encourage a dialogue for positive change.

PAMELA BRITTAIN AND MARY REID, University of Toronto, OISE
[Tuesday June 8 / mardi 8 juin, 13:30]
The intersections of math, gender and the model minority myth: Asian students' lived experiences in math schooling

The model minority myth upholds the perception that one race does better than others, based on a stereotypes of obedience, hard work, and innate talent ; while gender myths assume that one gender is weaker than the other at a specific task or subject. In the case of those who identify as Asian, they can often be faced with both myths at the same time in mathematics. So how do these stereotypes relate to each other and how does this affect their perceived abilities and beliefs in mathematics ? This research, in progress, seeks to gather information from Asian identifying members of the population to determine their

relationship with both the model minority myth and gender bias as it relates to mathematics. This presentation will provide background and insights into the topic and will provide some preliminary data from the study.

EDWARD DOOLITTLE, First Nations University of Canada
[Tuesday June 8 / mardi 8 juin, 12:30]

MARNI MISHNA, Simon Fraser University
[Wednesday June 9 / mercredi 9 juin, 12:30]
Can Canadian math institutes address equity in a meaningful way ?

In Canada a lot of support for mathematical events and young researchers is provided by regional math institutes. This talk will reflect on the urgency of an institute response to equity, diversity and inclusion in our discipline. We will identify principles to follow when building policy, and ideas for moving forward. We will also talk about some of the historical and structural challenges relevant to these issues from the perspective of an institute. This talk raise more questions than it will answer, with a goal of facilitating a necessary discussion between our mathematical community, and its leadership.

HERMIE MONTERDE, University of Manitoba
[Thursday June 10 / jeudi 10 juin, 13:45]
A Transgender Woman's Dilemma

In this presentation, we talk about the issues that transgender women face at large, and how these contribute to the lack of visibility and representation of transgender women, especially in Mathematics. We also discuss ways which can help promote the inclusion of transgender women in the Mathematics community.

ISRAEL NCUBE, Alabama A & M University
[Thursday June 10 / jeudi 10 juin, 12:30]
Reflections on impediments to equity, diversity, and inclusion in the mathematics professoriate

Many universities nowadays have developed elaborate statements and policy documents on equity, diversity, and inclusion. However, the reality on the ground is that these matters remain a far cry on many a university campus in Canada, and elsewhere. The disequilibrium that exists in equity, diversity, and inclusion is particularly stark in the mathematical sciences. It is important to understand the whys and the wherefores of this state of affairs. This talk will examine, in a frank and dispassionate manner, some of the issues that continue to challenge efforts aimed at making the mathematical sciences more welcoming, inclusive, diverse, and equitable.

ALEXANDRA WESOLEK, DANIELLE ROGERS, Simon Fraser University
[Thursday June 10 / jeudi 10 juin, 13:20]
Student project: Women Speaker Series

Simon Fraser University (SFU) has been host to a Discrete Math Seminar since the early 1980's. Unfortunately, over the past several years the gender distribution of speakers in this seminar has skewed overwhelmingly male. Indeed, this reflects a more general lack of inclusion at SFU as further indicated by SFU's Equity, Diversity and Inclusion report.

In the Fall of 2020, in a student led project, we decided to challenge the narrative by creating the Women in Discrete Math Speaker Series. In this talk we discuss the inspiration, implementation, and challenges behind this project. Additionally, we ask what the next steps in furthering EDI initiatives are.

Ergodic Theory, Dynamical Systems, Fractals and Applications
La théorie ergodique, les systèmes dynamiques, les fractales et les applications

Org: Jacopo de Simoi (Toronto) and/et **Shafiqul Islam** (PEI)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Chris Bose (University of Victoria), *Bounded distortion for random maps sampled across large parameter intervals.* (p. 123)
13:00 - 13:30	Peyman Eslami (Warwick University), *Exponential mixing for skew products with a holder roof function* (p. 123)
13:30 - 14:00	Pawel Gora (Concordia), *Periodic Islands for 2-dim Maps* (p. 123)
16:00 - 16:30	Christiane Rousseau (Montréal), *Polynomial vector fields on* $\mathbb{C}$ (p. 125)
16:30 - 17:00	Arno Berger (Alberta), *Digits and dynamics - an update* (p. 122)
17:00 - 17:30	Franklin Mendivil (Acadia University), *Sizes of rearrangements of linear Cantor sets* (p. 124)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Kouji Yano (Kyoto University), *Arcsine law for a piecewise linear random map* (p. 125)
10:30 - 11:00	Anthony Quas (University of Victoria), *Random compositions of Blaschke products* (p. 124)
12:30 - 13:00	James Yorke (University of Maryland), *Robust solutions in systems of equations* (p. 125)
13:00 - 13:30	Christopher Essex (Western), *The Entropy Production Paradox and Fractional Master Equations* (p. 123)
13:30 - 14:00	Illia Binder (Toronto), *Critical Interfaces and SLE: the rate of convergence* (p. 122)
14:00 - 14:30	Patrick Ingram (York), *Critical orbits of certain endomorphisms of projective space* (p. 124)
16:00 - 16:30	Kasun Fernando (Toronto), *The Bootstrap for Chaotic Dynamical Systems* (p. 123)
16:30 - 17:00	Shirou Wang (Alberta), *A coupling approach in the computation of geometric ergodicity for stochastic dynamics* (p. 125)
17:00 - 17:30	Matteo Tanzi (NYU), *Random-like properties of chaotic forcing* (p. 125)
17:30 - 18:00	Israel Ncube (Alabama A & M University), *Distributional statistical properties and the stability of an equilibrium of a delayed symmetric network* (p. 124)

Abstracts/Résumés

ARNO BERGER, University of Alberta
[Monday June 7 / lundi 7 juin, 16:30]
Digits and dynamics - an update

This talk presents a selection of results concerning the distribution of significant digits and significands, with an emphasis on data generated by dynamical processes (deterministic or random, linear or nonlinear, discrete or continuous). Several intriguing questions emerge naturally, pertaining to analysis, probability and number theory. (Based on joint work with G. Eshun, S. Evans, and T. Hill.)

ILLIA BINDER, University of Toronto
[Tuesday June 8 / mardi 8 juin, 13:30]
Critical Interfaces and SLE: the rate of convergence

I will describe the general framework for establishing the polynomial rate of convergence of critical lattice interfaces to SLE curves. I will also discuss the applications of this framework to various planar models of Statistical Physics, such as Ising, Harmonic Explorer, and Critical Percolation. The talk is based on joint works with Larissa Richards (University of Toronto) and Dmitry Chelkak (École normale supérieure).

CHRIS BOSE, cbose@uvic.ca
[Monday June 7 / lundi 7 juin, 12:30]
Bounded distortion for random maps sampled across large parameter intervals.

Recently, with Anthony Quas (Victoria) and Matteo Tanzi (NYU) we have established bounded distortion estimates for randomized intermittent Liverani-Saussol-Vaienti (LSV) maps sampled across the full parameter range. Obtaining bounded distortion is a key step in deriving decay of correlation asymptotics for iterated maps and all kinds of random maps. We will briefly outline how this works and discuss alternatives to bounded distortion that can be applied in some settings.

PEYMAN ESLAMI, University of Roma Tor vergata
[Monday June 7 / lundi 7 juin, 13:00]
Exponential mixing for skew products with a holder roof function

Consider the skew product $F(x,y) = (f(x), y+\tau(x))$ on $S^1 \times S^1$, where $f \in C^{1+}$, as the base map, is (piecewise) expanding. When τ, as the roof function, has C^{1+} regularity (and not locally constant) it is known that F mixes exponentially. However, in applications of this problem one is usually faced with g being only Holder continuous with exponent strictly less than one. I will discuss the exponential mixing of F in this more general situation.

CHRISTOPHER ESSEX, Applied Mathematics/Mathematics, UWO
[Tuesday June 8 / mardi 8 juin, 13:00]
The Entropy Production Paradox and Fractional Master Equations

The entropy production paradox concerns the unexpected and robust increase of entropy production rates as one moves away from the (irreversible) diffusion equation to approach the (reversible) wave equation. This unexpected behaviour was discovered while studying fractional diffusion equations meant to capture anomalous super diffusion. It has shown up robustly on different domains for distinct evolution equations with rather different probability density functions, all of which exhibit what we called pseudo propagation. Broadening this investigation to fractional master equations, on a bounded domain, leads to the paradox again, but only as a transient, which ultimately relaxes to classical expectations, providing insight into the original paradox and the nature of irreversibility.

KASUN FERNANDO, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:00]
The Bootstrap for Chaotic Dynamical Systems

Parameter estimation problems in dynamical systems arise naturally in many applications in machine learning, physics, biology, econometrics, and engineering. However, there are several standard statistical techniques that have not yet been implemented in the setting of dynamical systems. One such technique is the Bootstrap which is a widely-used resampling technique assigning measures of accuracy to sample estimates. In this talk, we introduce the Bootstrap for (exponentially mixing) dynamical systems. To establish its asymptotic accuracy, we establish the *continuous* Edgeworth expansions for dynamical systems. We also verify our theoretical results through simulations. This is joint work with Nan Zou (Macquarie University).

PAWEL GORA, Concordia University
[Monday June 7 / lundi 7 juin, 13:30]
Periodic Islands for 2-dim Maps

We consider a two dimensional map

$$G(x,y) = (y, f(\alpha y + (1-\alpha)x),$$

where $f(t) = 1 - 2|t - 1/2|$ is the tent map or $f(t) = 4t(1-t)$ is the logistic map, and $0 \leq \alpha \leq 1$ is a parameter.

For specific values of α the connected support of the absolutely continuous invariant measure (its existence is an unproven conjecture) disintegrates into a number of separate "islands" which still seem to support the acim. The map moves the islands periodically giving an example of a "weak chaos", a seemingly periodic motion which actually is chaotic.

We present a number of examples of periodic islands for different values of α. No theoretical results are presented, we only show computer generated images.

PATRICK INGRAM, York University
[Tuesday June 8 / mardi 8 juin, 14:00]
Critical orbits of certain endomorphisms of projective space

Post-critically finite (PCF) rational functions of one variable, those whose critical points all have finite forward orbit, are a natural class to consider in holomorphic dynamics. It follows from work of Thurston and McMullen that these functions do not occur in algebraic families, except for the Lattes examples. In higher dimension, less is known. This talk will use some tools from arithmetic geometry to say something about this problem for endomorphisms of $\mathbb{P}^N$ ramified along $N+1$ hyperplanes (in some sense the simplest ramification one could have).

FRANKLIN MENDIVIL, Acadia University
[Monday June 7 / lundi 7 juin, 17:00]
Sizes of rearrangements of linear Cantor sets

Each compact subset of $[0,1]$ is defined by its (countable) collection of complementary gaps. The collection of all of the lengths of these gaps encodes a great deal of information about the geometry of the set (in particular various dimensions). A "rearrangement" of a set has the same collection of gap lengths (but with a different ordering). In this talk we will give a brief survey of results about the "size" (box-counting, packing, Hausdorff, and Assouad dimensions) of rearrangements of a Cantor set. (Joint work with Ignacio Garcia, Kathryn Hare, and Leandro Zuberman)

ISRAEL NCUBE, Alabama A & M University
[Tuesday June 8 / mardi 8 juin, 17:30]
Distributional statistical properties and the stability of an equilibrium of a delayed symmetric network

We consider a certain class of Cohen-Hopfield-Grossberg symmetric networks characterised by multiple distributed time delays. We establish explicit analytical results on some ramifications of distributional heavy-tailedness on the stability boundary, in an appropriate parameter space, of an equilibrium of such a network. The premise of the approach adopted here is that very limited information about the time delays is available.

ANTHONY QUAS, University of Victoria
[Tuesday June 8 / mardi 8 juin, 10:30]
Random compositions of Blaschke products

We consider random compositions of Blaschke products and look at the corresponding Perron-Frobenius operators acting on densities. We study the Lyapunov exponents of these systems, and give a precise description of the Oseledets spectrum. (Joint work with Cecilia González-Tokman).

CHRISTIANE ROUSSEAU, Université de Montréal
[Monday June 7 / lundi 7 juin, 16:00]
Polynomial vector fields on $\mathbb{C}$

The study of polynomial vector fields $dz/dt = P(z)$ on $\mathbb{C}$ with complex methods was initiated by Douady, Estrada and Sentenac, who introduced a combinatorial invariant and an analytic invariant for generic vector fields. Together with Arnaud Chéritat, we introduced a new invariant, the periodgon, for polynomial vector fields of the form $dz/dt = z^k - \varepsilon$. In joint work with Martin Klimes, we generalized the periodgon for polynomial vector fields on $\mathbb{C}$. The periodgon is uniquely defined for "generic" vector fields, but genericity here is different from the notion introduced by Douady, Estrada and Sentenac. Furthermore, when the vector field varies, the deformation of the periodgon allows an immediate derivation of the bifurcation diagram. The study of polynomial vector fields on $\mathbb{C}$ was motivated by their importance in the study of unfoldings of parabolic points of diffeomorphisms and other similar questions.

MATTEO TANZI, CIMS, New York University
[Tuesday June 8 / mardi 8 juin, 17:00]
Random-like properties of chaotic forcing

We prove that skew systems with a sufficiently expanding base have "approximate" statistical properties similar to random ergodic Markov chains. For example, they exhibit approximate exponential decay of correlations, meaning that the exponential rate is observed modulo a controlled error. The fiber maps are only assumed to be Lipschitz regular and to depend on the base in a way that guarantees diffusive behaviour on the vertical component. The assumptions do not imply an hyperbolic picture and one cannot rely on the spectral properties of the transfer operators involved. The approximate nature of the result is the inevitable price one pays for having so mild assumptions on the dynamics on the vertical component. The error in the approximation is shown to go to zero when the expansion of the base tends to infinity.

SHIROU WANG, University of Alberta
[Tuesday June 8 / mardi 8 juin, 16:30]
A coupling approach in the computation of geometric ergodicity for stochastic dynamics

This talk introduces a probabilistic approach to numerically compute geometric convergence rates in discrete or continuous stochastic systems. Choosing appropriate coupling mechanisms and combining them together, this approach works well in many settings, especially in high-dimensions. It is particularly observed that the rate of geometric ergodicity of a randomly perturbed system can, to some extent, reveal the degree of chaoticity of the unperturbed system. This talk is based on a joint work with Yao Li.

KOUJI YANO, Kyoto University
[Tuesday June 8 / mardi 8 juin, 10:00]
Arcsine law for a piecewise linear random map

We construct a random interval map by choosing randomly two piecewise linear maps whose orbits converge to 0 or 1, and show that it obeys Thaler–Zweimüller's arcsine law. This talk is based on a joint work with Genji Hata and Toru Sera.

JAMES YORKE, Univ of Maryland College Park
[Tuesday June 8 / mardi 8 juin, 12:30]
Robust solutions in systems of equations

Joint work with Sana Jahedi and Tim Sauer.

We begin by asking what would we like (really smart) high-school students to know about systems of equations. A structured system of equations $F(x) = c$ where $F : \mathbb{R}^N \to \mathbb{R}^M$ is a system of M equations in which it is specified which of the N variables are allowed to appear in each equation. They are ubiquitous in mathematical modeling. Our goal in this article is to describe the global properties of solutions for structured systems of C^∞ functions. We describe general properties of solutions that follow from the system structure rather than from the particular details of the system. An important question when modeling natural systems is whether solutions are robust to small changes in the model. To address this question, we say F is "flat" if there exists an integer k such that for almost every x_0, the set $F^{-1}F(x_0)$ of solutions x of $F(x) = F(x_0)$ is a k-dimensional manifold. When $k = 0$, the solutions are isolated points. Systems of polynomials are examples of flat functions. But there are C^∞ functions F that are not flat, even when $N = M = 1$. We state conditions on vector spaces of C^∞ functions that imply that "almost every" (in the sense of prevalence) F in the vector space is k-flat for some k, and we show that if $k = M - N$ almost every F has the property that almost every x is a robust solution of $F(x) = c$ for some c. Then x is robust-to-small-changes in c and F.

Posted on arXiv 2021.

General Relativity
Relativité générale

Org: **Spyros Alexakis** and/et **Stefanos Aretakis** (Toronto)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
10:00 - 10:30	Matti Lassas, *Inverse problems for Einstein's equations and other non-linear hyperbolic equations* (p. 129)
10:30 - 11:00	Stefan Czimek, *The characteristic gluing problem of general relativity* (p. 127)
11:00 - 11:30	Robert McCann, *Inscribed radius bounds for lower Ricci bounded metric measure spaces with mean convex boundary* (p. 129)
11:30 - 12:00	Rita Teixeira da Costa, *Mode stability for extremal Kerr black holes* (p. 128)
12:00 - 12:30	Christoph Kehle, *Diophantine approximation as Cosmic Censor for AdS black holes* (p. 128)
12:30 - 13:00	William East, *Evolving Gravity Beyond Einstein* (p. 128)
13:00 - 13:30	Nathan Carruth, *Highly localised gravitational waves in polarised translational symmetry* (p. 127)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Eric Woolgar, *An almost splitting theorem and the topology of the Universe* (p. 130)
10:30 - 11:00	Hari Kunduri, *Classifying toric asymptotically flat gravitational instantons* (p. 129)
11:00 - 11:30	Marcus Khuri, *Lower Bounds for the Total Mass in 3-Dimensions* (p. 129)
11:30 - 12:00	Jacques Smulevici, *Recent results on the initial boundary value problem in GR* (p. 130)
12:00 - 12:30	Achilleas Porfyriadis, *Extreme Black Hole Anabasis* (p. 130)
12:30 - 13:00	Georgios Moschidis, *The instability of Anti-de Sitter spacetime for the Einstein-scalar field system* (p. 129)
13:00 - 13:30	Elena Giorgi, *The stability of charged black holes* (p. 128)

Abstracts/Résumés

NATHAN CARRUTH, University of Toronto/BIMSA
[Monday June 7 / lundi 7 juin, 13:00]
Highly localised gravitational waves in polarised translational symmetry

We discuss results on the existence of highly localised wave solutions to the vacuum Einstein equations in polarised translational symmetry. These require ancillary finite-time existence results for solutions with initial data whose amplitude and concentration make certain low Sobolev norms large. We describe a coordinate scaling extending the short-pulse ansatz of Christodoulou under which the initial amplitude becomes small, and show that existence follows from using decay obtained from a Klainerman-Sobolev inequality. We will then describe solutions which are highly spatially localised initially and remain so for finite time. We will discuss the possibility of obtaining measure-valued solutions by passing to a limit. This is joint work with Spyros Alexakis.

STEFAN CZIMEK, ICERM @ Brown University
[Monday June 7 / lundi 7 juin, 10:30]
The characteristic gluing problem of general relativity

In this talk we introduce the characteristic gluing problem for the Einstein vacuum equations. We show that the geometric obstructions to characteristic gluing of spacetimes are coming from conservation laws along null hypersurfaces. We identify

these conservation laws to be the conservation of energy, linear momentum, angular momentum and the equation of motion for the center of mass. Based on this identification, we explain how to characteristically glue a given spacetime to a suitably chosen Kerr spacetime. Moreover, we describe how our characteristic gluing method yields an alternative proof of the Corvino-Schoen gluing for spacelike initial data. This is joint work with S. Aretakis (Toronto) and I. Rodnianski (Princeton).

RITA TEIXEIRA DA COSTA, Cambridge
[Monday June 7 / lundi 7 juin, 11:30]
Mode stability for extremal Kerr black holes

The Teukolsky master equations are a family of PDEs describing the linear behavior of perturbations of the Kerr black hole family, of which the wave equation is a particular case.

We prove that, for extremal Kerr black holes, the Teukolsky equations admit no exponentially growing modes nor modes on the real axis. While the result was previously known for subextremal spacetimes, we show that the proof for the latter cannot be extended to the extremal case as the nature of the event horizon changes radically in the extremal limit.

WILLIAM EAST, Perimeter Institute
[Monday June 7 / lundi 7 juin, 12:30]
Evolving Gravity Beyond Einstein

Gravitational wave observations of black hole and other compact object mergers have provided an unparalleled way to test our understanding of gravity, and have already been used to constrain a number of possible deviations from general relativity. However, despite the success of these observations, for many theories that introduce modifications to the Einstein equations, there are limited or no results on the well-posedness of the resulting initial value problem. Thus it is unclear how to, or even if one can, obtain a full theoretical prediction of what happens, e.g., when two black holes merge. I will discuss some recent progress in this regard, in particular the introduction of the modified harmonic formulation of Horndeski theories of gravity, a general class of theories of a metric coupled to a scalar field that give second order equations of motion. Using numerical solutions in this formulation, and focusing on the particular case of Einstein-scalar-Gauss-Bonnet gravity as a first application, I will demonstrate its utility in evolving strong-field data, including black hole mergers, in a regime where the deviations from general relativity are significant. I will discuss some of the remaining challenges in understanding how to evolve modifications to general relativity.

ELENA GIORGI, Princeton University
[Tuesday June 8 / mardi 8 juin, 13:00]
The stability of charged black holes

Black holes solutions are parametrized by their mass, spin and charge. In this talk, I will motivate why the charge of black holes adds interesting dynamics to solutions of the Einstein equation thanks to the interaction between gravitational and electromagnetic radiations. Such radiations are solutions of a system of coupled wave equations with a symmetric structure which allows to define a combined energy-momentum tensor for the system. Finally, I will show how this physical-space approach is resolutive in the most general case of Kerr-Newman black hole, where the interaction between the radiations prevents the separability in modes.

CHRISTOPH KEHLE, ETH Zurich
[Monday June 7 / lundi 7 juin, 12:00]
Diophantine approximation as Cosmic Censor for AdS black holes

I will show an intimate connection between Diophantine approximation (associated to a small divisors problem) to the behavior of linear waves on black hole interiors with negative cosmological constant $\Lambda < 0$. We explore the consequences of this for the

C^0-formulation of Strong Cosmic Censorship and how its validity may change in an unexpected way according to the notion genericity imposed.

MARCUS KHURI, Stony Brook University
[Tuesday June 8 / mardi 8 juin, 11:00]
Lower Bounds for the Total Mass in 3-Dimensions

We provide lower bounds for the total mass of 3-dimensional initial data sets that are based on (spacetime) harmonic functions. The technique works for both the asymptotically flat and asymptotically hyperboloidal settings. These bounds are valid without the assumption of nonnegative scalar curvature or the dominant energy condition. However, if the energy condition is assumed then the result yields a new proof of the positive mass theorem.

HARI KUNDURI, Department of Mathematics and Statistics, Memorial University
[Tuesday June 8 / mardi 8 juin, 10:30]
Classifying toric asymptotically flat gravitational instantons

An asymptotically flat gravitational instanton is a 4d Riemannian manifold (M, g) that is complete, Ricci flat, and approaches a quotient of $\mathbb{R}^4$ with flat metric at infinity. In analogy with the classic black hole uniqueness theorem, Gibbons-Hawking and Lapedes conjectured that the two-parameter family of Kerr instantons on $\mathbb{R}^2 \times \mathbb{S}^2$ was the unique instanton invariant under a local torus action. However, Chen and Teo recently explicitly constructed a new family of such instantons on $\mathbb{CP}^2 \setminus \mathbb{S}^1$. I will discuss ongoing work on existence and uniqueness results for gravitational instantons in this class.

MATTI LASSAS, University of Helsinki
[Monday June 7 / lundi 7 juin, 10:00]
Inverse problems for Einstein's equations and other non-linear hyperbolic equations

We consider inverse problems for non-linear wave equations, for example, for the equation $\Box_g u + au^2 = f$ on a Lorentzian manifold (M, g). We study the question, do the observations of the solutions $u|_V$ on an open subset $V \subset M$, that correspond to sources f supported in V, determine the properties of the metric g in a larger domain $W \subset M$ containing V. The domain W can be the maximal domain to where the information sent from V can propagate and return back to V. In addition, we consider inverse problems for the coupled Einstein equations and matter field equations.

To study these problems we define the concept of light observation sets and show that these sets determine the conformal class of the metric.

The results have been done in collaboration with Ali Feizmohammadi, Yaroslav Kurylev, Lauri Oksanen, Gunther Uhlmann, and Yiran Wang.

ROBERT MCCANN, University of Toronto
[Monday June 7 / lundi 7 juin, 11:00]
Inscribed radius bounds for lower Ricci bounded metric measure spaces with mean convex boundary

Consider an essentially nonbranching metric measure space with the measure contraction property of Ohta and Sturm. We prove a sharp upper bound on the inscribed radius of any subset whose boundary has a suitably signed lower bound on its generalized mean curvature. This provides a nonsmooth analog of results dating back to Kasue (1983) in the Riemannian case and to Hawking (1966) in the Lorentzian case. We prove a stability statement concerning such bounds and — in the Riemannian curvature-dimension (RCD) setting — characterize the cases of equality. This represents joint work with Annegret Burtscher, Christian Ketterer and Eric Woolgar.

GEORGIOS MOSCHIDIS, UC Berkeley
[Tuesday June 8 / mardi 8 juin, 12:30]
The instability of Anti-de Sitter spacetime for the Einstein-scalar field system

The AdS instability conjecture provides an example of weak turbulence appearing in the dynamics of the Einstein equations in the presence of a negative cosmological constant. The conjecture claims the existence of arbitrarily small perturbations to the initial data of Anti-de Sitter spacetime which, under evolution by the vacuum Einstein equations with reflecting boundary conditions at conformal infinity, lead to the formation of black holes after sufficiently long time.

In this talk, I will present a rigorous proof of the AdS instability conjecture in the setting of the spherically symmetric Einstein-scalar field system. The construction of the unstable initial data will require carefully designing a family of initial configurations of localized matter beams and estimating the exchange of energy taking place between interacting beams over long periods of time, as well as estimating the decoherence rate of those beams. I will also discuss possible paths for extending these ideas to the vacuum case.

ACHILLEAS PORFYRIADIS, Harvard University
[Tuesday June 8 / mardi 8 juin, 12:00]
Extreme Black Hole Anabasis

We study the SL(2) transformation properties of spherically symmetric perturbations of the Bertotti-Robinson universe and identify an invariant μ that characterizes the backreaction of these linear solutions. The only backreaction allowed by Birkhoff's theorem is one that destroys the $AdS_2 \times S^2$ boundary and builds the exterior of an asymptotically flat Reissner-Nordstrom black hole with $Q = M\sqrt{1-\mu/4}$. We call such backreaction with boundary condition change an $anabasis$. We show that the addition of linear anabasis perturbations to Bertotti-Robinson may be thought of as a boundary condition that defines a $connected$ $AdS_2 \times S^2$. The connected AdS_2 is a nearly-AdS_2 with its SL(2) broken appropriately for it to maintain connection to the asymptotically flat region of Reissner-Nordstrom. We perform a backreaction calculation with matter in the connected $AdS_2 \times S^2$ and show that it correctly captures the dynamics of the asymptotically flat black hole.

JACQUES SMULEVICI, Sorbonne Université, Laboratoire Jacques-Louis Lions
[Tuesday June 8 / mardi 8 juin, 11:30]
Recent results on the initial boundary value problem in GR

I will review recent results obtained in collaboration with Grigorios Fournodavlos concerning the Initial Boundary Value Problem (IBVP) for the vacuum Einstein equations. In particular, I will explain how to formulate a well-posed IBVP for the Einstein equations in the maximal gauge and, in another setting, I will present a short proof of well-posedness for the IBVP in the case of umbilic boundary.

ERIC WOOLGAR, University of Alberta
[Tuesday June 8 / mardi 8 juin, 10:00]
An almost splitting theorem and the topology of the Universe

Cosmic microwave background observations show that the mass density of the Universe is enough to ensure its spatial closure, with about 70

Geometric Analysis
Analyse géométrique

Org: Robert Haslhofer (Toronto) and/et **Aaron Naber** (Northwestern)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
10:00 - 10:25	Siyuan Lu (McMaster), *Rigidity of Riemannian Penrose inequality with corners and its implications* (p. 132)
10:30 - 10:55	Spiro Karigiannis (Waterloo), *Towards higher dimensional Gromov compactness in G_2 and Spin(7) manifolds* (p. 132)
12:30 - 12:55	Salim Deaibes (University of Toronto), *Minimal Two-Spheres in Three-Spheres with an Arbitrary Metric* (p. 131)
13:00 - 13:25	Vitali Kapovitch (University of Toronto), *Mixed curvature almost flat manifolds* (p. 131)
13:30 - 13:55	Anthony McCormick (Northwestern), *Ladder Asymptotics on Stationary Spacetimes* (p. 132)
14:00 - 14:25	Christopher Kennedy (University of Toronto), *A Bochner Formula on Path Space for the Ricci Flow* (p. 132)
16:00 - 16:25	Jeff Streets (UC Irvine), *Generalized Ricci Flow* (p. 133)
16:30 - 16:55	Ailana Fraser (UBC), *Continuity of eigenvalues under degenerations* (p. 131)
17:00 - 17:25	Jerome Vetois (McGill), *Existence results for the higher-order Q-curvature equation* (p. 133)

Abstracts/Résumés

SALIM DEAIBES, University of Toronto
[Tuesday June 8 / mardi 8 juin, 12:30]
Minimal Two-Spheres in Three-Spheres with an Arbitrary Metric

In this talk, I will explain how we prove that every Riemannian three-sphere contains at least two embedded minimal two-spheres or admits an optimal foliation by two-spheres; I will also explain why we are unable to conclude the existence of two solutions in general. This improves results of White and Haslhofer-Ketover where the existence of at least two solutions has been established under the additional assumption that the metric has positive Ricci curvature or is generic, respectively.

AILANA FRASER, University of British Columbia
[Tuesday June 8 / mardi 8 juin, 16:30]
Continuity of eigenvalues under degenerations

We will discuss the question of the degenerations of Riemannian manifolds under which the first k Steklov eigenvalues are continuous. This question is important when one attempts to construct metrics which optimize an eigenvalue. As an application we describe several results concerning the optimization of higher Steklov eigenvalues. This talk includes joint work with R. Schoen and joint work with P. Sargent.

VITALI KAPOVITCH, University of Toronto
[Tuesday June 8 / mardi 8 juin, 13:00]
Mixed curvature almost flat manifolds

A celebrated theorem of Gromov says that given $n > 1$ there is an $\epsilon(n) > 0$ such that if a closed Riemannian manifold M^n satisfies $-\epsilon < sec_M < \epsilon, diam(M) < 1$ then M is diffeomorphic to an infranilmanifold. I will show that the lower sectional

curvature bound in Gromov's theorem can be weakened to the lower Bakry-Emery Ricci curvature bound. I will also discuss the relation of this result to the study of manifolds with Ricci curvature bounded below.

SPIRO KARIGIANNIS, University of Waterloo
[Tuesday June 8 / mardi 8 juin, 10:30]
Towards higher dimensional Gromov compactness in G_2 and Spin(7) manifolds

Let (M,ω) be a compact symplectic manifold with a compatible almost complex structure J. We can study the space of J-holomorphic maps $u\colon \Sigma \to (M,J)$ from a compact Riemann surface into M. By "compactifying" the space of such maps, one can obtain powerful global symplectic invariants of M. This requires understanding the ways in which sequences of such maps can develop singularities. Crucial ingredients are conformal invariance and an energy identity, which lead to to a plethora of analytic consequences, including: (i) a mean value inequality, (ii) interior regularity, (iii) a removable singularity theorem, (iv) an energy gap, and (v) compactness modulo bubbling.

Riemannian manifolds with closed G_2 or $\mathrm{Spin}(7)$ structures share many similar properties to such almost Kahler manifolds. In particular, they admit analogues of J-holomorphic curves, called associative and Cayley submanifolds, respectively, which are calibrated and hence homologically volume-minimizing. A programme initiated by Donaldson-Thomas-Segal aims to construct similar such "counting invariants" in these cases. In 2011, an overlooked preprint of Aaron Smith demonstrated that such submanifolds can be exhibited as images of a class of maps $u\colon \Sigma \to M$ satisfying a conformally invariant first order nonlinear PDE analogous to the Cauchy-Riemann equation, which admits an energy identity involving the integral of higher powers of the pointwise norm $|du|$. I will discuss joint work (to appear in Asian J. Math.) with Da Rong Cheng (Waterloo) and Jesse Madnick (NCTS/NTU) in which we establish the analogous analytic results of (i)-(v) in this setting. arXiv:1909.03512

CHRISTOPHER KENNEDY, University of Toronto
[Tuesday June 8 / mardi 8 juin, 14:00]
A Bochner Formula on Path Space for the Ricci Flow

Aaron Naber (Northwestern) and Robert Haslhofer (Toronto) have characterized solutions of the Einstein equation $\mathrm{Rc}(g) = \lambda g$ in terms of both sharp gradient estimates for Brownian motion and a Bochner formula on elliptic path space PM. They also successfully characterized solutions of the Ricci flow $\partial_t g = -2\mathrm{Rc}(g)$ in terms of an infinite-dimensional gradient estimate on parabolic path space $P\mathcal{M}$ of space-time $\mathcal{M} = M \times [0,T]$.

In this talk, we shall generalize the classical Bochner formula for the heat flow on evolving manifolds $(M, g_t)_{t\in[0,T]}$ to an infinite-dimensional Bochner formula for martingales, thus proving the parabolic counterpart of recent results in the elliptic setting as well as characterizing solutions of the Ricci flow in terms of Bochner inequalities on parabolic path space. Time-permitting, we shall also discuss gradient and Hessian estimates for martingales on parabolic path space as well as a condensed proof of previous characterizations of the Ricci flow.

SIYUAN LU, McMaster University
[Tuesday June 8 / mardi 8 juin, 10:00]
Rigidity of Riemannian Penrose inequality with corners and its implications

Motivated by the rigidity case in the localized Riemannian Penrose inequality, we show that suitable singular metrics attaining the optimal value in the Riemannian Penrose inequality is necessarily smooth in properly specified coordinates. If applied to hypersurfaces enclosing the horizon in a spatial Schwarzschild manifold, the result gives the rigidity of isometric hypersurfaces with the same mean curvature. This is a joint work with Pengzi Miao.

ANTHONY MCCORMICK, Northwestern University
[Tuesday June 8 / mardi 8 juin, 13:30]
Ladder Asymptotics on Stationary Spacetimes

The space of solutions to the wave equation on a principal bundle over a stationary spacetime decomposes in terms of isotypic representations of the structure group. We present a trace formula for the unitary time evolution operator when restricted to a ladder of representations and analyze the corresponding limit of large quantum numbers, providing a common extension of some results of Guillemin-Uribe and Strohmaier-Zelditch.

JEFF STREETS, UC Irvine
[Tuesday June 8 / mardi 8 juin, 16:00]
Generalized Ricci Flow

The generalized Ricci flow is a geometric evolution equation coupling the classic Ricci flow to equations for 'torsion,' and arises independently in mathematical physics, generalized geometry, and complex geometry. In this talk I will survey recent progress on this equation including new global existence results for the flow, and classification and rigidity results for generalized Ricci solitons.

JEROME VETOIS, McGill University
[Tuesday June 8 / mardi 8 juin, 17:00]
Existence results for the higher-order Q-curvature equation

In this talk, we will discuss the problem of prescribing the Q-curvature of order $2k$ on a closed Riemannian manifold of dimension $n > 2k$, where k is an integer. This amounts to solving a nonlinear elliptic PDE involving a $2k$-th order operator called the Graham-Jenne-Mason-Sparling (GJMS) operator. I will present new existence results for this problem under assumptions of coercivity of the operator and positivity of the Green's function, which are satisfied for instance when the manifold is Einstein. An additional positive mass assumption is also required in the case of small dimensions $2k + 1 \leq n \leq 2k + 3$ and locally conformally flat manifolds. This is a joint work with Saikat Mazumdar (Indian Institute of Technology Bombay).

Graph decompositions
Décompositions de graphes

Org: Andrea Burgess (New Brunswick) and/et **Mateja Sajna** (Ottawa)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Tommaso Traetta (Università di Brescia), *Highly symmetric Kirkman triple systems* (p. 138)
13:00 - 13:30	Peter Danziger (Ryerson University), *The Mini-Symposium Problem* (p. 135)
13:30 - 14:00	Melissa Keranen (Michigan Technological University), *Decomposing Graphs into Cycles* (p. 136)
16:00 - 16:30	Heather Jordon (Math Reviews), *Directed Cycle Systems via Signed Langford Sequences* (p. 136)
16:30 - 17:00	Doug Stinson (University of Waterloo), *On Progressive Dinner Parties and Related Combinatorial Structures* (p. 138)
17:00 - 17:30	Peter Dukes (University of Victoria), *Local balance in graph decompositions* (p. 135)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Anita Pasotti (Università di Brescia), *A reduction of the spectrum problem for sun systems* (p. 137)
10:30 - 11:00	Marco Buratti (Università degli Studi di Perugia), *Tales from cycle decompositions* (p. 134)
12:30 - 13:00	Francesca Merola (Università Roma Tre), *Equitably 2-colourable cycle systems* (p. 137)
13:00 - 13:30	Iren Darijani (Memorial University), *Colourings of star systems* (p. 135)
13:30 - 14:00	Adrian Pastine (Universidad Nacional de San Luis), *On the Hamilton-Waterloo problem with cycle lengths of distinct parities* (p. 137)
14:00 - 14:30	Marie Rose Jerade (University of Ottawa), *Honeymoon Oberwolfach Problem: Small Cases* (p. 136)
16:00 - 16:30	David Pike (Memorial University), *Perfect 1-Factorisations* (p. 137)
16:30 - 17:00	Amin Bahmanian (Illinois State University), *Embedding Connected Factorizations* (p. 134)
17:00 - 17:30	Sara Herke (University of Queensland), *Hamilton path decompositions of complete multipartite graphs* (p. 136)
17:30 - 18:00	Nick Cavenagh (Waikato University), *Heffter arrays and biembeddings of cycle systems* (p. 134)

Abstracts/Résumés

AMIN BAHMANIAN, Illinois State University
[Tuesday June 8 / mardi 8 juin, 16:30]
Embedding Connected Factorizations

An $(r_1, \ldots, r_q)$-factorization of the complete λ-fold h-uniform m-vertex hypergraph λK_m^h is a partition of the edges of λK_m^h into $F_1, \ldots, F_q$ such that each color class F_i is r_i-regular and spanning. We show that for $n \geq hm$, the obvious necessary conditions that ensure that an $(r_1, \ldots, r_q)$-factorization of λK_m^h can be extended to a connected $(s_1, \ldots, s_k)$-factorization of λK_n^h are also sufficient. This is joint work with Anna Johnsen (Illinois State) and Stefan Napirata (Universität Ulm).

MARCO BURATTI, Università di Perugia
[Tuesday June 8 / mardi 8 juin, 10:30]
Tales from cycle decompositions

I would like to give a roundup of unpublished results, problems, conjectures, and autobiographic stories concerning cycle decompositions.

NICK CAVENAGH, University of Waikato
[Tuesday June 8 / mardi 8 juin, 17:30]
Heffter arrays and biembeddings of cycle systems

In the last 20 years biembedding pairs of designs and cycle systems onto surfaces has been a muchresearched topic (see the 2007 survey "Designs and Topology" by Grannell and Griggs). In particular, in a posthumous work (2015), Archdeacon showed that biembeddings of cycle systems may be obtained via Heffter arrays. Formally, a Heffter array $H(m, n; s, t)$ is an $m \times n$ array of integers such that: (a) each row contains s filled cells and each column contains t filled cells; (b) the elements in every row and column sum to 0 in $\mathbb{Z}_{2ms+1}$; and (c) for each integer $1 \leq x \leq ms$, either x or $-x$ appears in the array. If we can order the entries of each row and column satisyfing two properties (compatible and simple), a Heffter array yields an embedding of two cycle decompositions of the complete graph K_{2ms+1} onto an orientable surface. Such an embedding is face 2-colourable, where the faces of one colour give a decomposition into s-cycles and the faces of the other colour gives a decomposition into t-cycles. Thus as a corollary the two graph decompositions are orthogonal; that is, any two cycles share at most one edge. Moreover, the action of addition in $\mathbb{Z}_{2ms+1}$ gives an automorphism of the embedding. We give more detail about the above and present a new result: the existence of Heffter arrays $H(n, n; s, s)$ with compatible and simple orderings whenever $s \equiv 3 \pmod 4$ and $n \equiv 1 \pmod 4$.

PETER DANZIGER, Ryerson universtiy
[Monday June 7 / lundi 7 juin, 13:00]
The Mini-Symposium Problem

Joint work with E. Mendelsohn, B. Stevens, T. Traetta.

The Oberwolfach problem was originally stated as a seating problem:

Given v attendees at a conference with t circular tables each of which seats a_i people $\left(\sum_{i=1}^{t} a_i = v\right)$. Find a seating arrangement so that every person sits next to each other person around a table exactly once over the r days of the conference.

The Oberwolfach problem thus asks for a decomposition of K_v ($K_v - I$ when v is even) into 2-factors consisting of cycles with lengths $a_1, \ldots, a_t$.

In this talk we introduce the related *mini-symposium problem,* which asks for solutions to the Oberwolfach problem on v points which contains a subsystem on m points. In the seating context above, the larger conference contains a mini-symposium of m participants, and we also require these m participants to be seated together for $\left\lfloor \frac{m-1}{2} \right\rfloor$ of the days.

We obtain a complete solution when the cycle sizes are as large as possible, m and $v - m$. In addition, we provide extensive results in the case where all cycle lengths are equal, of size k say, completely solving all cases when $m \mid v$, except possibly when k is odd and v is even. In particular, we completely solve the case when all cycles are of length m ($k = m$).

IREN DARIJANI, University of Lethbridge
[Tuesday June 8 / mardi 8 juin, 13:00]
Colourings of star systems

An e-star is a complete bipartite graph $K_{1,e}$. An e-star system of order $n > 1$, $S_e(n)$, is a partition of the edges of the complete graph K_n into e-stars. An e-star system is said to be k-colourable if its vertex set can be partitioned into k sets (called colour classes) such that no e-star is monochromatic. The system $S_e(n)$ is k-chromatic if $S_e(n)$ is k-colourable but is not $(k-1)$-colourable. If every k-colouring of an e-star system can be obtained from some k-colouring ϕ by a permutation of the colours, we say that the system is uniquely k-colourable. In this talk, we will first see some results on colourings of 3-star systems. Next, we generalize these results for e-star systems for any $e \geq 3$. Finally, we see some other results on unique colourings of e-star systems that for any $e \geq 3$.

PETER DUKES, University of Victoria
[Monday June 7 / lundi 7 juin, 17:00]
Local balance in graph decompositions

In a balanced graph decomposition, every vertex of the host graph appears in the same number of blocks. We propose the use of coloured loops as a framework for unifying various related local conditions in graph decompositions, including degree-balanced decompositions and equitable block colourings. In the basic case where a single graph with coloured loops is used as a block, an existence theory for such decompositions follows as a straightforward generalization of previous work on balanced graph decompositions. This talk is based on joint work with Flora C. Bowditch.

SARA HERKE, The University of Queensland
[Tuesday June 8 / mardi 8 juin, 17:00]
Hamilton path decompositions of complete multipartite graphs

If a graph with n vertices and m edges can be decomposed into edge-disjoint Hamilton paths, then $t = \frac{m}{n-1}$ is an integer, where t is the number of Hamilton paths, and the maximum degree is at most $2t$, because each Hamilton path has maximum degree 2. We give an overview of our proof that, for complete multipartite graphs, these conditions are also sufficient. This talk is based on joint work with Darryn Bryant and Hao Chuien Hang.

MARIE ROSE JERADE, University of Ottawa
[Tuesday June 8 / mardi 8 juin, 14:00]
Honeymoon Oberwolfach Problem: Small Cases

You are attending a conference where attendees consist of n couples. Couples must be seated next to each other every day of the conference, but next to every other person exactly once. At our disposal, we have t round tables that accommodate $m_1, m_2, ..., m_t$ attendees, respectively, such that $m_1 + m_2 + ... + m_t = 2n$ and each $m_i > 2$. This problem, nicknamed the Honeymoon Oberwolfach Problem, was introduced in [D. Lepine, M. Šajna, On the Honeymoon Oberwolfach Problem, *J. of Combin. Des.* **27** (2019), 420—447]. The authors showed that the problem has a solution for many general cases. Most important are the instances when all table sizes are the same, as well as for all $n \leq 9$.
In this talk, we present our computer-aided techniques based on the above-mentioned paper that allowed us to extend the latter result to all $n \leq 20$.

This is joint work with my research supervisor, Mateja Šajna.

HEATHER JORDON, American Mathematical Society
[Monday June 7 / lundi 7 juin, 16:00]
Directed Cycle Systems via Signed Langford Sequences

For positive integers d and t, a Langford sequence of order t and defect d is a sequence $\mathcal{L}_d^t = (s_1, \ldots, s_{2t})$ of length $2t$ that satisfies (i) for every $k \in \{d, d+1, \ldots, t+d-1\}$, there are exactly two elements $s_i, s_j \in \mathcal{L}_d^t$ such that $s_i = s_j = k$ and (ii) if $s_i = s_j = k$ with $i < j$, then $j - i = k$. Note that (ii) could be written as $j - i - k = 0$ or $i + k - j = 0$. Hence, one generalization of a Langford sequence is as follows. For positive integers d and t, a *signed* Langford sequence of order t and defect d is a sequence $\pm\mathcal{L}_d^t = (s_{-2t}, s_{-2t+1}, \ldots, s_{-1}, *, s_1, \ldots, s_{2t})$ of length $4t+1$ that satisfies (i) for every $k \in \pm\{d, d+1, \ldots t+d-1\}$, there are exactly two elements $s_i, s_j \in \pm\mathcal{L}_d^t$ such that $s_i = s_j = k$ and (ii) if $s_i = s_j = k$ with $i < 0 < j$, then $i + j + k = 0$. In this talk, we give necessary and sufficient conditions for the existence of a signed Langford sequence of order t and defect d for all positive integers d. We will then use these sequences to find cyclic decompositions of circulant digraphs into directed m-cycles for $m \geq 3$. In particular, we find a cyclic m-cycle decomposition of the complete symmetric digraph K_{2m+1}^* for all $m \geq 3$.

MELISSA KERANEN, Michigan Technological University
[Monday June 7 / lundi 7 juin, 13:30]
Decomposing Graphs into Cycles

A cycle decomposition is a partitioning of a graph's edges into cycles. A decomposition of the complete graph K_v into 2-factors where each 2-factor consists entirely of m-cycles is called a C_m-factorization. The Hamilton-Waterloo Problem, HWP$(v; m, n; \alpha, \beta)$ asks for a decomposition of K_v or $K_v - I$ into α C_m factors and β C_n-factors, where $3 \leq m \leq n$. In this presentation, I will discuss a technique that can be applied to solve some of the difficult cases in which $\alpha = 1$ or $\beta = 1$.

FRANCESCA MEROLA, Roma Tre University
[Tuesday June 8 / mardi 8 juin, 12:30]
Equitably 2-colourable cycle systems

An ℓ-cycle decomposition of a graph G is said to be equitably c-colourable if there is a c-vertex-colouring of G such that each colour is represented (approximately) an equal number of times on each cycle: more precisely, we ask that in each cycle C of the decomposition, each colour appears on $\lfloor \ell/c \rfloor$ or $\lceil \ell/c \rceil$ of the vertices of C. In this talk, we consider the case $c = 2$ and present some new results on the existence of 2-colourable even ℓ-cycle systems of the cocktail party graph $K_v - I$. In particular, we determine a complete existence result for equitably 2-colourable ℓ-cycle decompositions of $K_v - I$, ℓ even, in the cases that $v \equiv 0, 2 \pmod{\ell}$, or ℓ is a power of 2, or $\ell \in \{2q, 4q\}$ for q an odd prime power, or $\ell \leq 30$. We will also discuss some work in progress on analogous problems for cycles of odd length.

(Joint work with Andrea Burgess)

ANITA PASOTTI, Università degli Studi di Brescia
[Tuesday June 8 / mardi 8 juin, 10:00]
A reduction of the spectrum problem for sun systems

A k-cycle with a pendant edge attached to each vertex is called a k-sun. When we approached the existence problem for k-sun systems of order v, complete solutions were known only for $k = 3, 4, 5, 6, 8, 10, 14$ and for $k = 2^t$. Here, we reduce this problem to the orders v in the range $2k < v < 6k$ satisfying the obvious necessary conditions. Thanks to this result, we provide a complete solution whenever k is an odd prime, and some partial results whenever k is twice a prime. This talk is based on joint work with Marco Buratti and Tommaso Traetta.

ADRIAN PASTINE, Universidad Nacional de San Luis - IMASL (CONICET)
[Tuesday June 8 / mardi 8 juin, 13:30]
On the Hamilton-Waterloo problem with cycle lengths of distinct parities

The Hamilton-Waterloo problem asks for a decomposition of the complete graph into r copies of a 2-factor F_1 and s copies of a 2-factor F_2 such that $r+s = \lfloor \frac{v-1}{2} \rfloor$. If F_1 consists of m-cycles and F_2 consists of n cycles, then we call such a decomposition a $(m, n) - HWP(v; r, s)$. The goal is to find a decomposition for every possible pair (r, s). This problem has been studied in great depth in the cases when m and n have the same parity and $1 \notin \{r, s\}$. In this work, we use dihedral groups to obtain decompositions of the form $(m, n) - HWP(v; r, s)$ when both m and n have different parities. We also obtain decompositions when m and n have the same parity and $1 \in \{r, s\}$. This talk is based on joint work with Andrea Burgess, Peter Danziger and Tommaso Traetta.

DAVID PIKE, Memorial University of Newfoundland
[Tuesday June 8 / mardi 8 juin, 16:00]
Perfect 1-Factorisations

A matching in a graph G is a subset $M \subseteq E(G)$ of the edge set of G such that no two edges of M share a vertex. A 1-factor of a graph G is a matching F in which every vertex of G is in one of the edges of F. If G is a Δ-regular graph of even order then we can ask whether G admits a 1-factorisation, namely a partition of its edge set into Δ 1-factors.

Suppose that $F_1, F_2, \ldots, F_\Delta$ are the 1-factors of a 1-factorisation $\mathcal{F}$ of a Δ-regular graph G. If, for each $1 \leq i < j \leq \Delta$, the union $F_i \cup F_j$ is the edge set of a Hamilton cycle in G, then we say that $\mathcal{F}$ is a perfect 1-factorisation of G. We will discuss some of the history and properties of 1-factorisations, including the recent discovery of a perfect 1-factorisation of K_{56}.

DOUG STINSON, University of Waterloo
[Monday June 7 / lundi 7 juin, 16:30]
On Progressive Dinner Parties and Related Combinatorial Structures

Julian Regan asked if it possible to design a progressive dinner party that involves a number of couples, having each course of a three-course meal at a different person's house, with three couples at each course, every couple hosting once and no two couples meeting more than once. This problem can be generalized to a k course meal with k couples at each course. The number of couples, say v, must be divisible by k. We can solve this problem for almost permissible values of v when $k \leq 13$. In this talk, I will discuss solution techniques, as well as connections with resolvable symmetric configurations and resolvable Golomb rulers. Part of this talk is based on joint work with Marco Buratti.

TOMMASO TRAETTA, Università di Brescia
[Monday June 7 / lundi 7 juin, 12:30]
Highly symmetric Kirkman triple systems

Kirkman triple systems (KTSs) are among the most popular combinatorial designs and their existence has been settled a long time ago. Yet, in comparison with Steiner triple systems, little is known about their automorphism groups. In particular, there is no known congruence class representing the orders of a KTS with a number of automorphisms at least close to the number of points. We fill this gap by proving that whenever $v \equiv 39 \pmod{72}$, or $v \equiv 4^e 48 + 3 \pmod{4^e 96}$ and $e \geq 0$, there exists a KTS on v points having at least $v - 3$ automorphisms.

To obtain these results we introduced new types of difference families and difference matrices which will be discussed in this talk.

This is joint work with S. Bonvicini, M. Buratti, M. Garonzi, and G. Rinaldi.

Harmonic Analysis and Partial Differential Equations
Analyse harmonique et équations différentielles partielles

Org: Almaz Butaev (Calgary) and/et **Galia Dafni** (Concordia)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Marta Lewicka (University of Pittsburgh), *On the Monge-Ampere system* (p. 143)
13:00 - 13:30	Marius Mitrea (Baylor University), *Singular Integrals, Geometry of Sets, and Boundary Problems* (p. 143)
13:30 - 14:00	Ryan Alvarado (Amherst College), *Optimal embeddings and extensions for Triebel-Lizorkin spaces in spaces of homogeneous type* (p. 140)
16:00 - 16:30	Dorina Mitrea (Baylor University), *A Sharp Divergence Theorem* (p. 143)
16:30 - 17:00	Zachary Bradshaw (University of Arkansas), *Non-decaying solutions to the critical surface quasi-geostrophic equations with symmetries* (p. 140)
17:00 - 17:30	Damir Kinzebulatov (Université Laval), *Heat kernel bounds and stochastic equations with singular (form-bounded) drift* (p. 142)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Ritva Hurri-Syrjänen (University of Helsinki), *On the John-Nirenberg Space* (p. 142)
13:00 - 13:30	Jean Van Schaftingen (Université Catholique de Louvain), *Marcinkiewicz meets Gagliardo and Sobolev: weak-type formulas for norms of the gradient* (p. 145)
13:30 - 14:00	Nages Shanmugalingam (University of Cincinnati), *Using hyperbolic fillings to connect Besov spaces of functions on doublling metric space to Sobolev functions on uniform domains* (p. 144)
14:00 - 14:30	Sagun Chanillo (Rutgers University), *Local Version of Courant's Nodal Domain Theorem* (p. 140)
16:00 - 16:30	Guy C. David (Ball State University), *Quantitative decompositions of Lipschitz mappings* (p. 141)
16:30 - 17:00	Tomas Merchán (Kent State University), *Huovinen transform and rectifiability* (p. 143)
17:00 - 17:30	Alex Stokolos (Georgia Southern University), *"An extremal problem for polynomials"* (p. 145)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:00	Ignacio Uriarte-Tuero (University of Toronto), *Two weight norm inequalities for singular and fractional integral operators in* $\mathbb{R}^n$ (p. 145)
13:00 - 13:30	David Cruz-Uribe (University of Alabama), *Sharp constant estimates for matrix weighted inequalities* (p. 141)
13:30 - 14:00	Cody Stockdale (Clemson University), *Weighted theory of compact operators* (p. 144)
14:00 - 14:30	Tatyana Barron (University of Western Ontario), *Weighted Bergman spaces on the ball and submanifolds* (p. 140)
16:00 - 16:30	Scott Rodney (Cape Breton University), *Iterations in PDEs* (p. 144)
16:30 - 17:00	Luda Korobenko (Reed University), *Continuity of weak solutions via the trace method* (p. 142)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Claudio Machado Vasconcelos (Universidade Federal de São Carlos), *On the continuity of Calderón-Zygmund-type operators on Hardy spaces* (p. 143)
13:00 - 13:30	Virginia Naibo (Kansas State University), *Pseudo-multipliers on Hermite Besov and Hermite Triebel-Lizorkin spaces* (p. 144)
13:30 - 14:00	Paul Hagelstein (Baylor University), *On the finiteness of strong maximal functions associated to functions whose integrals are strongly differentiable* (p. 141)
14:00 - 14:30	Ryan Gibara (Université Laval), *Dyadic structure theorems for strong function spaces* (p. 141)

16:00 - 16:30	Krystal Taylor (Ohio State University), *Quantifications of the Besicovitch Projection theorem in a nonlinear setting* (p. 145)
16:30 - 17:00	J. Michael Wilson (University of Vermont), *Perturbation of dyadic averages* (p. 146)
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Abstracts/Résumés

RYAN ALVARADO, Amherst College
[Monday June 7 / lundi 7 juin, 13:30]
Optimal embeddings and extensions for Triebel-Lizorkin spaces in spaces of homogeneous type

Embedding and extension theorems for certain classes of function spaces in $\mathbb{R}^n$ (such as Sobolev spaces) have played a fundamental role in the area of partial differential equations. In this talk, we will discuss some recent work which builds upon such results and identifies necessary and sufficient conditions guaranteeing that certain Sobolev-type inequalities and extension results hold for the scale of Triebel-Lizorkin spaces ($M^s_{p,q}$ spaces) in the general context of spaces of homogeneous type. An interesting facet of this work is how the range of s (the smoothness parameter) for which these inequalities and extension results hold is intimately linked to the geometric makeup of the underlying space. This talk is based on joint work with Dachun Yang and Wen Yuan.

TATYANA BARRON, University of Western Ontario
[Wednesday June 9 / mercredi 9 juin, 14:00]
Weighted Bergman spaces on the ball and submanifolds

I will talk about certain finite-dimensional subspaces of weighted Bergman spaces on the unit ball in $\mathbb{C}^n$. Informally speaking, to a submanifold M of the ball one can associate an element f of this function space, by integrating the Bergman kernel over M. I will talk about norm estimates on f, and how they reflect the geometry of M.

ZACHARY BRADSHAW, University of Arkansas
[Monday June 7 / lundi 7 juin, 16:30]
Non-decaying solutions to the critical surface quasi-geostrophic equations with symmetries

We discuss a theory of self-similar solutions to the critical surface quasi-geostrophic equations due to Dallas Albritton and Z.B. In particular, we examine a construction of self-similar solutions for arbitrarily large data in various regularity classes—including some large, unbounded, non-decaying functions—and demonstrate, in the small data regime, uniqueness and global asymptotic stability. These solutions are non-decaying at spatial infinity, which leads to ambiguity in the drift velocity. This ambiguity is corrected by imposing m-fold rotational symmetry. The self-similar solutions of interest lie just beyond the known well-posedness theory and are expected to shed light on potential non-uniqueness, due to the possibility of symmetry-breaking bifurcations.

SAGUN CHANILLO, Rutgers University
[Tuesday June 8 / mardi 8 juin, 14:00]
Local Version of Courant's Nodal Domain Theorem

Given a compact Riemannian manifold with no boundary (M^n, g) endowed with a smooth metric g, one of the important objects of study is the Laplace-Beltrami operator and its eigenfunctions. That is

$$-\Delta u_k = \lambda_k u_k.$$

The Courant nodal domain theorem asserts that the k-th eigenfunction has at most k nodal domains, where a nodal domain is a connected component of the set $\{x|\ u_k(x) \neq 0\}$. Harold Donnelly and C. Fefferman initiated the study of local versions of this result with a goal to show that nodal domains cannot be long and narrow. This was related to a conjecture of S.-T. Yau on the length of the nodal set. The nodal set is the set $\{x|\ u_k(x) = 0\}$. In this joint work with A. Logunov, E. Mallinikova and D. Mangoubi, we obtain an optimal bound for results of this type.

DAVID CRUZ-URIBE, The University of Alabama
[Wednesday June 9 / mercredi 9 juin, 13:00]
Sharp constant estimates for matrix weighted inequalities

In this talk we will review some recent work on strong (p, p) and weak $(1, 1)$ inequalities with matrix weights: e.g., inequalities of the form

$$\int_{\mathbb{R}^n} |W^{1/p}(x)T\mathbf{f}(x)|^p\,dx \leq C\int_{\mathbb{R}^n} |W^{1/p}(x)\mathbf{f}(x)|^p\,dx,$$

$$|\{x \in \mathbb{R}^n : |W(x)T(W^{-1}\mathbf{f})(x)| > t\}| \leq \frac{C}{t}\int_{\mathbb{R}^n} |\mathbf{f}(x)|\,dx.$$

W is an $n \times n$ self-adjoint, positive semi-definite matrix that satisfies the matrix A_p condition, and T is a Calderón-Zygmund operator. We will also mention results for the Golderg maximal operator and commutators. We will conclude with some open questions in both the scalar and matrix weighted cases.

This is joint work with Kabe Moen, Josh Isralowitz, Sandra Pott and Israel Rivera-Rios.

GUY C. DAVID, Ball State University
[Tuesday June 8 / mardi 8 juin, 16:00]
Quantitative decompositions of Lipschitz mappings

Given a Lipschitz map, it is often useful to chop the domain into pieces on which the map has simple behavior. For example, depending on the dimensions of source and target, one may ask for pieces on which the map behaves like a bi-Lipschitz embedding or like a linear projection. It is even more useful if this decomposition is quantitative, i.e., with bounds independent of the particular map or spaces involved. After surveying the question of bi-Lipschitz decomposition, we will discuss the more complicated case in which dimension decreases, e.g., for maps from $\mathbb{R}^3$ to $\mathbb{R}^2$. This is joint work with Raanan Schul, improving a previous result of Azzam-Schul.

RYAN GIBARA, Université Laval
[Thursday June 10 / jeudi 10 juin, 14:00]
Dyadic structure theorems for strong function spaces

The space $BMO(\mathbb{R}^n)$ can be shown to coincide with the intersection of N dyadic-type BMO spaces, where $N > 1$. Moreover, it is known that the sharp (i.e. smallest possible) value for N is $n + 1$. In joint work with José Conde-Alonso, we consider the case of strong $BMO(\mathbb{R}^n)$, where mean oscillation is bounded over all rectangles with sides parallel to the axes. We exploit the product structure inherent to rectangles and inherited by strong $BMO(\mathbb{R}^n)$ to show that an analogous result holds for this function space with $N = 2$ regardless of the dimension. Other function spaces such as BLO and VMO are also considered.

PAUL HAGELSTEIN, Baylor University
[Thursday June 10 / jeudi 10 juin, 13:30]
On the finiteness of strong maximal functions associated to functions whose integrals are strongly differentiable

Besicovitch proved that if f is an integrable function on $\mathbb{R}^2$ whose associated strong maximal function $M_S f$ is finite a.e., then the integral of f is strongly differentiable. On the other hand, Papoulis proved the existence of a function in $L^1(\mathbb{R}^2)$ (taking on both positive and negative values) whose integral is strongly differentiable but whose associated strong maximal function is infinite on a set of positive measure. In this talk, we discuss a recent result of Hagelstein and Oniani that if $f \in L^1(\mathbb{R}^n)$ is a *nonnegative* function whose integral is strongly differentiable and moreover such that $f(1+\log^+ f)^{n-2}$ is integrable, then $M_S f$ is finite a.e. This result is sharp in that, if ϕ is a convex increasing function on $[0,\infty)$ such that $\phi(0)=0$ and with $\phi(u) = o(u(1+\log^+ u)^{n-2})$ $(u \to \infty)$, then there exists a nonnegative function f on $\mathbb{R}^n$ such that $\phi(f)$ is integrable on $\mathbb{R}^n$ and the integral of f is strongly differentiable, although $M_S f$ is infinite on a set of positive measure.

RITVA HURRI-SYRJÄNEN, University of Helsinki
[Tuesday June 8 / mardi 8 juin, 12:30]
On the John-Nirenberg Space

The talk will address 'from local to global' questions for functions in the John-Nirenberg space. When inequalities are known to be true locally, we will discuss corresponding global results for functions defined in bounded domains. My talk is based on joint work with Niko Marola and Antti V. Vähäkangas.

DAMIR KINZEBULATOV, Université Laval
[Monday June 7 / lundi 7 juin, 17:00]
Heat kernel bounds and stochastic equations with singular (form-bounded) drift

I will talk about recent results on sharp two-sided heat kernel bounds for divergence-form parabolic equations with drift having critical singularities, and related results on stochastic differential and stochastic transport equations. The talk is based on joint papers with K.R.Madou, Yu.A.Semenov and R.Song.

LUDA KOROBENKO, Reed College
[Wednesday June 9 / mercredi 9 juin, 16:30]
Continuity of weak solutions via the trace method

In this talk I will discuss some new regularity results for weak solutions to infinitely degenerate elliptic equations on the plane. The main result is continuity of weak solutions for operators that have bounded measurable coefficients and are only comparable to the diagonal operator of the form $\partial_x^2 + f^2(x)\partial_y^2$, which can be seen as a generalization of Fedĭ'ı's remarkable hypoellipticity theorem. To establish this result, we develop a trace method that first constructs a region in $\mathbb{R}^2$ on whose boundary a given subsolution u has a suitable trace, and then applies a maximum principle to derive local boundedness and continuity of weak solutions.

CHUN HO LAU, Concordia University
[Thursday June 10 / jeudi 10 juin, 17:00]
Endpoint boundedness of the commutators of localized singular integral operators and bmo functions

We investigate the analogue of Perez' endpoint results for commutators in terms of the local Hardy space $h^1(\mathbb{R}^n)$ of Goldberg. In this talk, I will discuss the boundedness from the subspace $h^1_b(\mathbb{R}^n)$ to L^1 and to h^1 of the commutator $[b,\mathcal{T}]$, where b is in the nonhomogeneous BMO space (Goldberg's bmo) and $\mathcal{T}$ is in a class of singular integral operators which includes the

localized Riesz transforms. These results make use of a higher dimensional version of the molecular decomposition for $h^1(\mathbb{R})$ given by Dafni and Liflyand.

MARTA LEWICKA, University of Pittsburgh
[Monday June 7 / lundi 7 juin, 12:30]
On the Monge-Ampere system

The Monge-Ampere equation $\det \nabla^2 u = f$ posed on a $N = 2$ dimensional domain, has a natural weak formulation that appears as the constraint condition in the Γ-limit of the dimensionally reduced non-Euclidean elastic energies. This formulation reads: $curl^2(\nabla v \otimes \nabla v) = -2f$ and it allows, via the Nash-Kuiper scheme of convex integration, for constructing multiple solutions that are dense in $C^0(\omega)$, at the regularity $C^{1,\alpha}$ for any $\alpha < 1/7$.

Does a similar result hold in higher dimensions $N > 2$? Indeed it does, but one has to replace the Monge-Ampere equation by a *"Monge-Ampere system"*, altering $curl^2$ to the corresponding operator whose kernel consists of the symmetrised gradients of N-dimensional displacement fields. We will show how this Monge-Ampere system arises from the prescribed Riemannian curvature problem by matched asymptotic expansions, similarly to how the prescribed Gaussian curvature problem leads to the Monge-Ampere equation in 2d, and prove that its flexibility at $C^{1,\alpha}$ for any $\alpha < 1/(N^2 + N + 1)$.

CLAUDIO MACHADO VASCONCELOS, Universidade Federal de São Carlos
[Thursday June 10 / jeudi 10 juin, 12:30]
On the continuity of Calderón-Zygmund-type operators on Hardy spaces

In this talk, we will discuss some boundedness results for strongly singular Calderón-Zygmund operators on Hardy spaces $H^p(\mathbb{R}^n)$ and its local version $h^p(\mathbb{R}^n)$ for $0 < p \leq 1$. Operators of this type are generalizations of *weakly-strongly multipliers* and include appropriate classes of pseudodifferential operators in the Hörmander class. In particular, we assume some L^s-type integral estimates on their kernel and present some interesting molecular decomposition of $h^p(\mathbb{R}^n)$, in which a weaker cancellation condition is assumed.

This is joint work with Tiago Picon (University of São Paulo), Galia Dafni and Chun Ho Lau (Concordia University).

TOMAS MERCHÁN, University of Minnesota
[Tuesday June 8 / mardi 8 juin, 16:30]
Huovinen transform and rectifiability

A major theorem of Tolsa, building upon prior work of Mattila-Preiss, states that if $E \subset \mathbb{R}^d$ with $\mathcal{H}^s(E) < \infty$ ($s \in \mathbb{Z}$), and the s-Riesz transform associated to E exists in principal value, then the set E is s-rectifiable. It has been an open problem if the analogous theorem holds in the case of the Huovinen transform (which has kernel $K(z) = z^k/|z|^{k+1}$ in $\mathbb{C}$ for k odd) for sets of positive and finite length. In the talk we will discuss this problem.

DORINA MITREA, Baylor University
[Monday June 7 / lundi 7 juin, 16:00]
A Sharp Divergence Theorem

In this talk I will discuss a version of the Divergence Theorem for vector fields which may lack any type of continuity and for which the boundary trace is taken in a strong, nontangential pointwise sense. These features of our brand of Divergence Theorem make it an effective tool in dealing with problems arising in various areas of mathematics, including Harmonic Analysis, Complex Analysis, Potential Analysis, and Partial Differential Equations. A few such applications will be presented.

MARIUS MITREA, Baylor University
[Monday June 7 / lundi 7 juin, 13:00]
Singular Integrals, Geometry of Sets, and Boundary Problems

Presently, it is well understood what geometric features are necessary and sufficient to guarantee the boundedness of convolution-type singular integral operators (SIO's) on Lebesgue spaces. This being said, dealing with other function spaces where membership entails more than a mere size condition (like Sobolev spaces, Hardy spaces, or the John-Nirenberg space BMO) requires new techniques. In this talk I will explore recent progress in this regard, and follow up the implications of such advances into the realm of boundary value problems.

VIRGINIA NAIBO, Kansas State University
[Thursday June 10 / jeudi 10 juin, 13:00]
Pseudo-multipliers on Hermite Besov and Hermite Triebel-Lizorkin spaces

We will present boundedness properties of pseudo-multipliers with symbols of Hörmander-type in function spaces associated to the Hermite operator. The main tools in the proofs involve new molecular decompositions and molecular synthesis estimates for Hermite Besov and Hermite Triebel-Lizorkin spaces, which allow to obtain boundedness results on spaces for which the smoothness allowed includes non-positive values. In particular, we obtain continuity results for pseudo-multipliers on Lebesgue and Hermite local Hardy spaces. This is based on joint work with Fu Ken Ly (The University fo Sydney).

SCOTT RODNEY, Cape Breton University
[Wednesday June 9 / mercredi 9 juin, 16:00]
Iterations in PDEs

In this talk I will discuss some recent progress on joint work with D. Cruz-Uribe (University of Alabama) and S.F. MacDonald (CBU) concerning the boundedness of weak solutions to equations of the form

$$-\mathrm{Div}\,(Q(x)\nabla u(x)) = f(x)$$

in a bounded domain Ω of $\mathbb{R}^n$ with $n \geq 4$ and where $Q(x)$ is a symmetric non-negative definite matrix valued function on Ω. Using a De Giorgi iterative process we produce boundedness results for weak solutions u when the data function f belongs to an Orlicz class $L^{\Psi}(\Omega)$ where Ψ is a particular type of Young function satisfying $\Psi(t) > t^{n/2}$.

NAGES SHANMUGALINGAM, University of Cincinnati
[Tuesday June 8 / mardi 8 juin, 13:30]
Using hyperbolic fillings to connect Besov spaces of functions on doublling metric space to Sobolev functions on uniform domains

In this talk we will describe a way of identifying Besov spaces of functions on a compact doubling metric measure space as traces of Sobolev spaces on uniform domains. Functions in Besov spaces have non-local energy and so it is advantageous from the point of view of regularity theory to associate them with more local energy spaces such as Sobolev spaces. This talk is based on joint work with Anders Bjorn and Jana Bjorn.

CODY STOCKDALE, Clemson University
[Wednesday June 9 / mercredi 9 juin, 13:30]
Weighted theory of compact operators

The boundedness properties of singular integral operators are of central importance in analysis. Within the last decade, optimal bounds for general Calderón-Zygmund operators acting on weighted Lebesgue spaces in terms of Muckenhoupt weight characteristics have been obtained. In addition to this theory concerning boundedness, a theory for compactness of Calderón-Zygmund operators has recently been established. The first goal of this talk is to present the extension of compact Calderón-Zygmund theory to weighted spaces using sparse domination techniques. A similar line of research concerns the weighted boundedness of the Bergman projection in terms of Bekollé-Bonami weights, and compactness in this setting can be understood within the study of Toeplitz operators. We also discuss the weighted theory of Toeplitz operators on the Bergman space.

ALEX STOKOLOS, Georgia Southern University
[Tuesday June 8 / mardi 8 juin, 17:00]
"An extremal problem for polynomials"

In 1987 M.Brandt solved the extremal problem

$$\sup_{a_2,\ldots,a_N}\left(\inf_{z\in\mathbb{D}}\left\{\Re\left(F\left(z\right)\right):\Im\left(F\left(z\right)\right)=0\right\}\right)$$

for the univalent in $\mathbb{D}$ polynomials $F(z)=\sum_{j=1}^{N}a_jz^j$ with real coefficients and normalization $a_1=1$. He proved that the solution is $-\frac{1}{4}\sec^2\frac{\pi}{N+2}$, and found the extremal polynomial. We prove that the above problem stated for general (not necessary univalent) polynomials has the same solution and the same extremizer. Moreover, we prove the uniqueness of the extremizer and obtain the estimate on the Koebe radius for polynomials in various settings. This is a joint work with Dmitriy Dmitrishin and Andrey Smorodin.

KRYSTAL TAYLOR, The Ohio State Math Department
[Thursday June 10 / jeudi 10 juin, 16:00]
Quantifications of the Besicovitch Projection theorem in a nonlinear setting

There are many classical results relating the geometry, dimension, and measure of a set to the structure of its orthogonal projections. It turns out that many nonlinear projection-type operators also have special geometry that allows us to build similar relationships between a set and its "projections," just as in the linear setting. We will discuss a series of recent results from both geometric and probabilistic vantage points. In particular, we will see that the multi-scale analysis techniques of Tao, as well as the energy techniques of Mattila, can be strengthened and generalized to projection-type operators satisfying a transversality condition. As an application, we find upper and lower bounds for the rate of decay of the Favard curve length of the four-corner Cantor set.

IGNACIO URIARTE-TUERO, University of Toronto
[Wednesday June 9 / mercredi 9 juin, 12:30]
Two weight norm inequalities for singular and fractional integral operators in $\mathbb{R}^n$

I will report on recent progress on the two weight problem for singular and fractional integral operators in $\mathbb{R}^n$, in particular a two weight local Tb theorem in higher dimensions.

Joint work with Christos Grigoriadis, Michalis Paparizos, Eric Sawyer, Chun-Yen Shen.

JEAN VAN SCHAFTINGEN, UCLouvain
[Tuesday June 8 / mardi 8 juin, 13:00]
Marcinkiewicz meets Gagliardo and Sobolev: weak-type formulas for norms of the gradient

I will present new results characterising Sobolev norms of functions with Marcinkiewicz weak-type estimates for the integrand of the Gagliardo semi-norm and their application to detection of constant functions and repairing the fractional Gagliardo–Nirenberg interpolation at endpoints where it fails.

This is a joint work with Haim Brezis (Rutgers, Technion Haifa and Sorbonne) and Po Lam Yung (Chinese University of Hong Kong and Australian National University).

J. MICHAEL WILSON, University of Vermont
[Thursday June 10 / jeudi 10 juin, 16:30]
Perturbation of dyadic averages

If $f : \mathbf{R}^d \to \mathbf{C}$ is locally integrable and $E \subset \mathbf{R}^d$ is bounded and measurable, with positive Lebesgue measure $|E|$, then f_E means f's average over E: $f_E := \frac{1}{|E|}\int_E f\,dt$. $\mathcal{D}$ denotes the family of dyadic cubes in $\mathbf{R}^d$. By the Lebesgue Differentiation Theorem, for a.e. $x \in \mathbf{R}^d$, $f_Q \to f(x)$ as $|Q| \to 0$, for $Q \in \mathcal{D}$ such that $x \in Q$. Suppose that, for some fixed $0 < \eta \ll 1$, and for every $Q \in \mathcal{D}$, we have an $n \times n$ real matrix $A^{(Q)}$ and a vector $y^{(Q)} \in \mathbf{R}^d$ such that: a) $\|I_d - A^{(Q)}\|_\infty < \eta$, where I_d is the identity matrix and $\|\cdot\|_\infty$ is the standard matrix norm ; b) $|y^{(Q)}| \le \eta$. For each $Q \in \mathcal{D}$ define

$$\begin{aligned} F^{(Q)}(x) &:= \chi_Q\left(A^{(Q)}(x - x_Q + \ell(Q)y^{(Q)}) + x_Q\right) \\ &=: \chi_{Q^*}(x), \end{aligned}$$

where x_Q is Q's center. We think of Q^* as a perturbation of Q resulting from a close-to-the-identity affine transformation "centered" on x_Q. The averages f_{Q^*} converge to a.e. x as $|Q| \to 0$ for $x \in Q \in \mathcal{D}$.

Elementary estimates with the Hardy-Littlewood maximal function show that, for all $s > 2$, there are constants $c(d) > 0$ and $C(d,s)$ so that if $\eta < c(d)$ then, for all $f \in L^2(\mathbf{R}^d)$,

$$\left\| \sup_{x \in Q \in \mathcal{D}} |f_Q - f_{Q^*}| \right\|_2 \le C(d,s)\eta^{1/s}\|f\|_2.$$

We improve this to get: *There are constants $c(d) > 0$ and $C(d)$ so that if $\eta < c(d)$ then, for all $f \in L^2(\mathbf{R}^d)$,*

$$\left\| \left(\sum_{x \in Q \in \mathcal{D}} |f_Q - f_{Q^*}|^2 \right)^{1/2} \right\|_2 \le C(d)\eta^{1/2}\|f\|_2.$$

History and Philosophy of Mathematics
Histoire et philosophie des mathématiques

Org: **Tom Archibald** and/et **Nicolas Fillion** (SFU)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Vincent Ardourel (IHPST- Paris) (p. 147)
13:00 - 13:30	Jemma Lorenat (Pitzer College), *"I see the ellipsoid from inside" : responses from Galton's 1880 questionnaire on the faculty of visualising* (p. 148)
13:30 - 14:00	Naftali Weinberger (Munich), *Simpson's Paradox and Tests of Racial Discrimination* (p. 149)
14:00 - 14:30	Deborah Kent (St Andrews), *Experimentation and Mathematics: P.G. Tait at the Old Course* (p. 147)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:00	Davide Rizza (East Anglia), *Salient phases of mathematical problem-solving* (p. 148)
13:00 - 13:30	Jabel Ramirez (University. de la Laguna), *The philosophical heritage of Leibniz' mathesis universalis in modern computational mathematics* (p. 148)
13:30 - 14:30	Brenda Davison (SFU), *Stokes and the Pendulum* (p. 147)

Abstracts/Résumés

VINCENT ARDOUREL, IHPST- Paris
[Tuesday June 8 / mardi 8 juin, 12:30]

BRENDA DAVISON, SFU
[Wednesday June 9 / mercredi 9 juin, 13:30]
Stokes and the Pendulum

During the first half of the 19th century, the pendulum occupied an important place in experimental physics and in surveying. Precision pendulum measurements were used, for example, to determine accurate values of the gravitational constant and to determine the exact shape of the earth. The desire for exceedingly precise measurement meant that temperature, humidity, altitude, external vibrations, and the medium through which the pendulum swung had to be controlled or corrected for. Simultaneous measurements being made at a variety of locations around the world meant that assurance was needed that what was being compared from one location to the other was actually comparable. Further, theory was needed to support the various experimental results and to predict the effect of changing conditions on the pendulum period. In particular, the computation, from theory, of a vacuum to air correction factor for a given pendulum was important. Sir George Gabriel Stokes provided this theory in 1848 and he used divergent series to do so. This talk will use a portion of the fascinating history of the pendulum during the early 19th century to establish their importance and then will take a close look at the mathematics that Stokes developed in support of this effort.

DEBORAH KENT, University of St. Andrews
[Tuesday June 8 / mardi 8 juin, 14:00]
Experimentation and Mathematics: P.G. Tait at the Old Course

Nineteenth-century mathematician and physicist Peter Guthrie Tait (1831-1901) is widely known for his collaborations with Maxwell, Hamilton, and Thomson. Less familiar are his extensive aerodynamical studies. In the 1890s, Tait published over a

dozen papers on the path of a rotating spherical projectile. Tait's classic work on the trajectory of golf balls was experimentally tested on the course at St. Andrews with the help of his son, celebrated amateur golfer Freddie Tait. P.G. Tait realized that the combination of a dimpled surface and backspin created lift that allowed the ball to exceed the maximum expected distance.

JEMMA LORENAT, Pitzer College
[Tuesday June 8 / mardi 8 juin, 13:00]
"I see the ellipsoid from inside" : responses from Galton's 1880 questionnaire on the faculty of visualising

Between November 1879 and April 1880, Francis Galton circulated a questionnaire on Mental Imagery to colleagues, schools, professional societies, and journal contributors. He received responses from 107 men, 180 women, and hundreds of schoolchildren. Galton restricted his statistical analysis and publications to the results from 100 men ("at least half of whom are distinguished in science or in other fields of intellectual work") and 172 boys from the Charterhouse School.

Among the women whose responses were consigned to the obscurity of a few vaguely qualitative remarks were Charlotte Angas Scott and Constance Herschel, fellow students at Girton College in Cambridge, who would both become resident lecturers there. Their responses and accompanying letters to Galton have been preserved and digitized by the University College London Digital Collections alongside all of Galton's surviving correspondence on Mental Imagery.

This talk will situate the responses from Scott and Herschel on the imagery of geometry and numerals with respect to their mathematical training and popular perceptions (including Galton's) of sex differences in imagery and abstract thought.

JABEL RAMIREZ, University of La Laguna
[Wednesday June 9 / mercredi 9 juin, 13:00]
The philosophical heritage of Leibniz' mathesis universalis in modern computational mathematics

In the Regulae, Descartes writes that there must be a "general science that explains everything that is possible to explain concerning order and measure, without assigning any particular measure." This science was called mathesis universalis. Leibniz later picked up this idea and developed it in various essays between 1666 and 1704. Leibniz would have distinguished between a characteristica universalis or lingua characteristica and a calculus ratiocinator. The first would consist of a rational language of thought, whose mission would be to directly represent our concepts and their relationships, that is, the conceptual structure of the world ; while the second would constitute a symbolic calculation whose aim would be the algorithmization of reasoning, of human thought. This distinction signified the emergence of two currents with opposing views on the nature of the mathesis universalis, or universal symbolic language. On the one hand, the "algebraic" school of Boole, Peirce and Schröder, and, on the other hand, mainly Frege, who in his Begriffsschrift opts for a characteristica universalis. These two visions affect, as Jean van Heijenoort points out, logic, which can be considered a language or a calculation, but it also transcends in linguistics with the works of Jakko Hintikka. They also gave rise to Carnap's proposal for a universal language of logical and physicalist science. In this work we propose to investigate the possible relationships between these concepts and the epistemological characterization of computational mathematics ; In this sense, we will analyze whether they have calculus or language properties in the Leibnizian sense.

DAVIDE RIZZA, University of East Anglia
[Wednesday June 9 / mercredi 9 juin, 12:30]
Salient phases of mathematical problem-solving

Recent philosophical discussions concerning the application of mathematics focus on the correspondence between empirical and mathematical structures (since Field (1980)) or on the issue of explanation (since Baker (2005)).

As a result, the analysis of applications has been persistently subjected to a counterproductive focus. In particular, the problem-solving character of applications has been concealed. Little attention has been paid to the fact that, in scientific enquiry, interrelated problems, rather than structured settings, present themselves first. Settings arise from after successful problem-solving techniques have been crystallised. Moreover, only after systematic work to bring problems under control has been carried

out is it possible to consider certain facts as results of formal analysis, i.e. it is only after the construction of a problem-solving methodology by mathematical means that explanations arise as, possibly significant, byproducts.

My goal on this presentation is to refocus the study of applications around problem-solving and away from mirroring and explanation. I offer some reflections on what important phases of mathematised enquiry should be given prominence as a subject of closer analysis. In order to keep contact with mathematical practice, I develop my reflections in connection with the development of mathematical voting theory (especially Saari (1994)).

References: Baker, A. (2005) 'Are there genuine mathematical explanations of physical phenomena?', Mind 114, pp.223–238. Field, H. (1980) Science without numbers. Oxford: Clarendon Press. Saari, D.G. (1994) Geometry of Voting. New York: Springer.

NAFTALI WEINBERGER, Munich

[Tuesday June 8 / mardi 8 juin, 13:30]

Simpson's Paradox and Tests of Racial Discrimination

Simpson's paradox is a well known statistical phenomenon in which a probabilistic association in a population reverses, emerges, or disappears when the population is partitioned into subpopulations. Despite the existence of satisfactory probabilistic and causal analyses of the paradox, it continues to be a source of confusion among scientists and philosophers. In my talk, I illustrate the significance of the paradox for benchmark tests of racial discrimination. Neil and Winship (2019) correctly note that the paradox undermines the uncritical use of such tests, but their analysis is weakened by severe misconceptions about the paradox. I show how the causal analysis of the paradox avoids these errors and highlight the under-appreciated role of causal methodology for interpreting data.

Hopf Algebras and Related Topics
Algèbres de Hopf et sujets connexes

Org: Yevgenia Kashina (DePaul), **Mikhail Kotchetov** (Memorial University) and/et **Yorck Sommerhauser** (Memorial University)

Schedule/Horaire

Wednesday June 9 — **mercredi 9 juin**

12:30 - 13:00	Susan Montgomery (University of Southern California), *Actions of pointed Hopf algebras on matrix rings* (p. 153)
13:00 - 13:30	Yuri Bahturin (Memorial University of Newfoundland), *Polynomial identities of algebras with the action of Hopf algebras* (p. 151)
13:30 - 14:00	Miodrag Iovanov (University of Iowa), *On Combinatorial Hopf Algebras* (p. 152)
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Abstracts/Résumés

MARCELO AGUIAR, Cornell University
[Wednesday June 9 / mercredi 9 juin, 16:00]
Double monoids in duoidal categories: a brief tour and an example in geometric combinatorics

The notion of a bimonoid in a braided monoidal category is familiar to Hopf algebraists. We will discuss related but less familiar notions such as that of a double monoid. The ambient setting for the latter is that of a duoidal category. We will introduce these concepts along with examples, with the hope of reaching an example of a $(2,1)$-monoid in the category of Joyal's species which is of a beautiful geometric and combinatorial nature: it is built out of a class of polytopes called generalized permutahedra.

The talk borrows on various earlier projects done in collaboration with Swapneel Mahajan, Federico Ardila, and Jose Bastidas.

YURI BAHTURIN, Memorial University of Newfoundland
[Wednesday June 9 / mercredi 9 juin, 13:00]
Polynomial identities of algebras with the action of Hopf algebras

In a joint paper with Felipe Yukihide Yasumura, we prove the following. Suppose we are given a Hopf algebra H and two H-simple finite-dimensional H-algebras A and B, over an algebraically closed field F. If A and B have the same polynomial H-identities then A and B are isomorphic as H-algebras.

STEFAAN CAENEPEEL, Vrije Universiteit Brussel, VUB
[Thursday June 10 / jeudi 10 juin, 10:00]
Frobenius Galois Rings and Corings

Brzeziński observed that the language of corings can be applied to give a unified approach to Galois theories that existed in the literature, such as Galois theory for field and commutative ring extensions with action by a finite group, Hopf-Galois theory, Galois theory for entwining structures and others. In view of duality, the theory becomes more elegant if we consider an coring that is finitely generated and projective over the base ring. However, the nicest situation is when the coring is Frobenius (that is, it is a Frobenius monoid in the category of bimodules). For instance, we do not need flatness assumptions in order to have a structure theorem. For example, the coring that is needed in order to describe Galois theory for commutative ring extensions with a finite group action (or even a finite partial group action or a partial finite groupoid action is Frobenius. The aim of this talk is develop a streamlined theory, based on the notions of Frobenius pairs and Frobenius monads in 2-categories.

STEFAN CATOIU, DePaul University
[Friday June 11 / vendredi 11 juin, 13:00]
Generalized trigonometric and hyperbolic Hopf algebras

We generalize the trigonometric Hopf algebra and the less known hyperbolic Hopf algebra. One application of these is to number theory, by providing the right generalization of the Pythagorean equation and the right generalization of Fermat's Last Theorem. Another application is to Hopf algebras, namely, to the classification of finite dimensional pointed Hopf algebras.

WILLIAM CHIN, DePaul University
[Wednesday June 9 / mercredi 9 juin, 16:30]
Coverings of pointed coalgebras and pseudocompact algebras

Every coalgebra over an algebraically closed field is Morita-Takeuchi equivalent to a pointed coalgebra. Every pointed coalgebra can be embedded in the path coalgebra of its Gabriel quiver. We describe how topological coverings of quivers can be used to produce coverings of coalgebras. For non-Galois coverings the covering coalgebras are realized as smash coproducts over G-sets

for the fundamental group G. The comodule category of the covering is then equivalent to the category of comodules graded by the G-set. The theory can be dualized to pseudocompact algebras and completed smash coproducts.

JUAN CUADRA, University of Almeria
[Thursday June 10 / jeudi 10 juin, 10:30]
Non-existence of integral Hopf orders for twists of simple groups of Lie type

In the papers [1] and [2] we discovered an arithmetic difference between group algebras and semisimple Hopf algebras; namely, *complex semisimple Hopf algebras may not admit integral Hopf orders.* This reveals that, unlike group algebras, Kaplansky's sixth conjecture can not be proved through the property that semisimple Hopf algebras are defined over number rings.

The families of examples for which this phenomenon occurs turn out to be simple Hopf algebras. The following question was proposed in [2]:

Let G be a finite group and Ω a non-trivial twist for $\mathbb{C}G$, arising from an abelian subgroup, such that the twisted Hopf algebra $(\mathbb{C}G)_\Omega$ is simple. Can $(\mathbb{C}G)_\Omega$ admit an integral Hopf order?

In this talk we will show that this question has a negative answer for several families of finite simple groups of Lie type, which include: special/projective special linear groups of order 2 and 3, special/projective special unitary groups of order 3, and the Suzuki groups.

The results that will be presented are part of a work in progress joint with Giovanna Carnovale and Elisabetta Masut (University of Padova, Italy).

References

[1] J. Cuadra and E. Meir, *On the existence of orders in semisimple Hopf algebras.* Trans. Amer. Math. Soc. 368 (2016), 2547-2562.

[2] _____, *Non-existence of Hopf orders for a twist of the alternating and symmetric groups.* J. London Math. Soc. (2) 100 (2019) 137-158.

ALEXEI DAVYDOV, Ohio University
[Thursday June 10 / jeudi 10 juin, 13:00]

JÖRG FELDVOSS, University of South Alabama
[Friday June 11 / vendredi 11 juin, 13:30]
Projective Modules and Blocks of a Hopf Algebra

In this talk I will explain how certain projective modules of a finite-dimensional Hopf algebra H can be employed to estimate the number of isomorphism classes of the irreducible H-modules and the number of the blocks of H. Some of this is motivated by joint work with Salvatore Siciliano and Thomas Weigel on restricted Lie algebras.

TERRY GANNON, University of Alberta
[Friday June 11 / vendredi 11 juin, 15:30]
Quantum SL2 and logarithmic vertex operator algebras

The category of modules of rational vertex operator algebras are relatively well understood. The best understood family of nonrational vertex operator algebras are the so-called triplet algebras. Their category of modules have been conjectured to coincide with the representation category of small quantum SL2 at a root of unity. My talk will review this conjecture, and explain its recent proof by Cris Negron and myself.

MIODRAG IOVANOV, University of Iowa
[Wednesday June 9 / mercredi 9 juin, 13:30]
On Combinatorial Hopf Algebras

We introduce a combinatorial structure which generalizes graphs, multigraphs, hypergraphs, simplicial and delta complexes, colored graphs and more, which we call multi-complexes. It has a Hopf algebra structure similar to that of the Hopg algebra of graphs, where the isomorphism types of multi-complexes provide a basis and multiplication and comultiplication record assembly and disassembly combinatorial information. We find a basis of in the space of primitives of this Hopf algebra, which has combinatorial relevance in as the formulas giving the original basis in terms of primitives have non-negative integer coefficients. We give cancellation and grouping free formulas for the primitives, and also obtain the cancellation and grouping free formula for the antipode. This recovers such formulas in various other particular cases. Time permitting, we explain how some conjectures in combinatorics (specifically, graph theory) can be approached via this setup. This work is joint with Jaiung Jun.

VLADISLAV KHARCHENKO, UNAM
[Wednesday June 9 / mercredi 9 juin, 14:00]
Quantizations as quadratic-linear Koszul algebras

The Koszul algebras arise in many areas of the modern mathematics: algebraic geometry, representation theory, noncommutative geometry, topology, number theory, theory of pseudoroots of noncommutative polynomials. We prove that in q-Weyl generators the multi-parameter Drinfeld-Jimbo quantizations of type A_n^+ and B_n^+ are quadratic-linear Koszul algebras

ALAN KOCH, Agnes Scott College
[Friday June 11 / vendredi 11 juin, 10:30]
Abelian maps, Hopf-Galois structures, and solutions to the Yang-Baxter equation

Let L/K be a nonabelian Galois extension, and let $G = \mathrm{Gal}(L/K)$. Let $\psi : G \to G$ be an endomorphism whose image is an abelian subgroup of G. We construct a K-Hopf algebra H_ψ and show that L/K is an H_ψ-Galois extension. A Hopf-Galois structure on L/K allows us to construct two skew left braces, each of which in turn gives a non-degenerate, set-theoretic solution to the Yang-Baxter equation. We explicitly describe the two skew left braces as well as the corresponding solutions.

MITJA MASTNAK, Saint Mary's University
[Friday June 11 / vendredi 11 juin, 15:00]
A cohomological approach to liftings

The classification of various certain kinds of pointed Hopf algebras (and more generally Hopf Algebras with the Chevalley property) involves first describing a graded (over non-negative integers) Hopf algebra and then describing all its liftings, i.e., filtered Hopf algebras whose associated graded Hopf algebra is one of the fixed graded Hopf algebra we found in step one. In my talk I will present some ideas and recent results involved in a cohomological approach to computing liftings of a fixed graded Hopf algebra.

SUSAN MONTGOMERY
[Wednesday June 9 / mercredi 9 juin, 12:30]
Actions of pointed Hopf algebras on matrix rings

Let H be a finite dimensional pointed Hopf algebra with an abelian group G of group-like elements, over a field k which contains all the n^{th} roots of 1, for $n = |G|$. We determine actions of H on matrices $M_m(k)$. We obtain a complete answer

when H is a Taft algebra, and partial answers for other H, in particular the Drinfeld double of the Taft algebra, for smaller matrices. Our techniques use the classification of group gradings of matrices by Bahturin, Sehgal, and Zaicev. This work is joint with Yuri Bahturin

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SIU-HUNG NG, Louisiana State University
[Thursday June 10 / jeudi 10 juin, 14:00]
Witt groups and signatures of modular tensor categories

In this talk, we introduce the notion of signatures of fusion categories. These signatures can be extended to Witt invariants of modular or super-modular categories. The higher central charges of any modular category can be expressed in terms of its first central charge and signature. The signatures of an infinite sequence of quantum group modular categories are proved to be $\mathbb{Z}_2$-linearly independent, which implies a conjecture of Davydov-Nikshych-Ostrik on the super-Witt group. This talk is based on a joint work with Eric Rowell, Yilong Wang and Qing Zhang.

DMITRI NIKSHYCH, University of New Hampshire
[Thursday June 10 / jeudi 10 juin, 12:30]
On the braid group representations coming from weakly group-theoretical fusion categories

Objects of braided tensor categories give rise to representations of braid groups. These representations are used to construct invariants of knots and links and to study topological models for quantum computing. One would like to understand a relation between these representations and the structure of the original category. We prove that braid group representations coming from weakly group-theoretical braided fusion categories have finite images. This extends the finiteness result of Etingof, Rowell, and Witherspoon for group-theoretical categories. We explicitly compute the braid group images coming from Drinfeld doubles of dihedral groups. This is a report on the joint work with Jason Green.

VICTOR OSTRIK, University of Oregon
[Thursday June 10 / jeudi 10 juin, 13:30]
Frobenius exact symmetric tensor categories.

I will report on a joint work in progress with K.Coulembier and P.Etingof. We give a characterization of symmetric tensor categories over fields of positive characteristic which admit an exact tensor functor to the Verlinde category ; in particular we give a characterization of Tannakian categories. A crucial ingredient of this characterization is exactness of the Frobenius twist functor which mimics the Frobenius twist for representations of algebraic groups.

JULIA PLAVNIK, Indiana University
[Thursday June 10 / jeudi 10 juin, 16:00]
Algebraic structures in group-theoretical fusion categories

In this talk, we will present an explicit construction of Morita equivalence class representatives of indecomposable, separable algebras in group-theoretical fusion categories. This generalizes the result by Ostrik (2003) and Natale (2017) that a collection of twisted group algebras in a pointed fusion category serve as explicit Morita equivalence class representatives of indecomposable, separable algebras in such categories. We will explain the construction of our algebras and good algebraic properties that they enjoy.

This talk is based on joint work with Y. Morales, M. Müller, A. Ros Camacho, A. Tabiri, C. Walton.

PAUL TRUMAN, Keele University
[Friday June 11 / vendredi 11 juin, 10:00]
Isomorphism problems for Hopf-Galois structures and skew braces

Let L/K be a finite Galois extension of fields and let $\mathcal{S}$ denote the set of Hopf-Galois structures on L/K. Each Hopf-Galois structure in $\mathcal{S}$ consists of a Hopf algebra H and a certain K-linear action of H on L; a natural way to partition $\mathcal{S}$ is to identify Hopf-Galois structures whose underlying Hopf algebras are isomorphic. On the other hand, each of these Hopf-Galois structures corresponds to a skew brace; another way to partition $\mathcal{S}$ is to identify Hopf-Galois structures whose corresponding skew braces are isomorphic. We use the interplay between these two partitions of $\mathcal{S}$ to study the Hopf algebras and skew braces involved. In particular, we show that in some cases the isomorphism class of the Hopf algebra giving a Hopf-Galois structure is determined by the corresponding skew brace. This is joint work with Alan Koch (Agnes Scott College).

HENRY TUCKER, University of California, Riverside
[Thursday June 10 / jeudi 10 juin, 16:30]
Frobenius-Schur indicators for some families of quadratic fusion categories

The family quadratic fusion categories provides most of the examples of "exotic" fusion categories, i.e. not coming from finite, Lie, or quantum groups. Recently, Izumi and Grossman families of modular data that are conjectured to give the modular data of Drinfel'd centers of the quadratic fusion categories in general. (In fact, it is true for all known examples.) Using this new modular data, we compute the categorical Frobenius-Schur indicators for these families, an important categorical invariant for fusion categories. Moreover, we look more closely at the relationship between indicators in the fusion category and indicators in its center. This is a preliminary report.

ROBERT UNDERWOOD, Auburn University at Montgomery
[Friday June 11 / vendredi 11 juin, 12:30]
Hopf Orders in $K[C_p^3]$ in Characteristic p

Let p be a prime number, let K be a field of characteristic p that is complete with respect to a discrete valuation, and let C_p^3 denote the elementary abelian group of order p^3. We construct a large collection of Hopf orders in the K-Hopf algebra $K[C_p^3]^*$ and compute their dual Hopf orders in $K[C_p^3]$.

Low dimensional topology
Topologie en basses dimensions

Org: Idrissa Ba and/et **Adam Clay** (Manitoba)

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13:00 - 13:30	Jonathan Johnson (UT Austin), *Bi-Orderability and Branched L-Space Knots* (p. 157)
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Abstracts/Résumés

HANS BODEN, McMaster University
[Thursday June 10 / jeudi 10 juin, 13:30]
The Gordon-Litherland pairing for knots in thickened surfaces

We introduce the Gordon-Litherland (GL) pairing for knots and links in thickened surfaces that bound unoriented spanning surfaces. Using the GL pairing, we define several invariants (signature, determinant, and nullity) and discuss how to compute them from the Tait graph and Goeritz matrix associated to a checkerboard surface. The invariants depend very weakly on the choice of spanning surface, and in fact only on its S^*-equivalence class.

We will discuss several applications to problems such as detecting the minimal supporting genus, determining sliceness, and

slice genus of virtual knots. The GL pairing can also be regarded as the relative intersection pairing on a 4-manifold obtained as the 2-fold cover along the surface. This talk represents joint work in progress with M. Chrisman and H. Karimi.

TYRONE GHASWALA, Université du Québec à Montréal
[Friday June 11 / vendredi 11 juin, 10:30]
Boundary Dehn twists are excellent

Suppose you have a compact orientable surface with one boundary component. It is known that the Dehn twist about a curve isotopic to the boundary component is not quite like all the other Dehn twists. For one thing, it is central in the mapping class group of the surface. I will prove that such Dehn twists are co-final in every left-ordering of the mapping class group, making them even cooler than originally thought! I will then discuss what this tells us about mapping class group actions on the real line and the fractional Dehn twist coefficient.

This is work in progress with Adam Clay.

YING HU, University of Nebraska Omaha
[Wednesday June 9 / mercredi 9 juin, 10:00]
Slope detection and toroidal 3-manifolds

The L-space Conjecture says that for a prime 3-manifold, properties NLS (not being an L-space), LO (having left-orderable fundamental group), and CTF (admitting a co-orientable taut foliation), are equivalent.

We investigate these properties for toroidal 3-manifolds through the notion of slope detection. We show that all toroidal integer homology spheres are LO, and that the n-fold cyclic branched covers of a prime satellite knot are NLS and LO, and are CTF if its companion is fibered. We also prove a partial extension of the latter result to links and confirm a folklore conjecture that prime satellite links are never quasi-alternating.

This is joint work with Steve Boyer and Cameron Gordon.

KASIA JANKIEWICZ, University of Chicago
[Friday June 11 / vendredi 11 juin, 12:30]
Boundary rigidity for groups acting on product of trees

The visual boundary is a well-defined compactification of a hyperbolic or CAT(0) space. For hyperbolic groups the boundary is unique up to homeomorphism. However, Croke-Kleiner constructed examples of CAT(0) groups acting geometrically on CAT(0) spaces with non-homeomorphic boundaries. I will discuss the question of the uniqueness of the boundary for groups acting geometrically on product of two trees. This is a wide family of groups including product of free groups, as well as some simple groups. This is joint work with Annette Karrer, Kim Ruane and Bakul Sathaye.

JONATHAN JOHNSON, University of Texas at Austin
[Wednesday June 9 / mercredi 9 juin, 13:00]
Bi-Orderability and Branched L-Space Knots

The orderability of 3-manifold groups has become a topic of interest in the last couple of decades. For example, the L-space conjecture posits a surprising relationship between the left-orderability of the fundamental group of a rational homology sphere, the foliations of that manifold, and the manifold's Heegaard Floer homology. However, the fundamental groups of 3-manifolds with positive first Betti number are always left-orderable. In particular, knot groups are left-orderable. In this situation, bi-orderability is more illuminating. In this talk, I will discuss a couple of results on the bi-orderability of knot groups, and how these results are related to properties of the cyclic branched covers of a knot.

HOMAYUN KARIMI, McMaster University
[Thursday June 10 / jeudi 10 juin, 14:00]
A characterization of alternating links in thickened surfaces

We use an extension of Gordon-Litherland pairing to thickened surfaces to give a topological characterization of alternating links in thickened surfaces. If Σ is a closed oriented surface and F is a compact unoriented surface in $\Sigma \times I$, then the Gordon-Litherland pairing defines a symmetric bilinear pairing on the first homology of F. A compact surface in $\Sigma \times I$ is called definite if its Gordon-Litherland pairing is a definite form. We prove that a non-split link L in a thickened surface is alternating if and only if it bounds two definite surfaces of opposite sign. This is joint work with Hans U. Boden.

HEEJOUNG KIM, University of Illinois at Urbana-Champaign
[Friday June 11 / vendredi 11 juin, 13:00]
End-periodic homeomorphisms and volumes of mapping tori

The Mapping class group $Map(S)$ of a finite type surface S has been studied and generally well understood. In particular, there is the Nielsen-Thurston classification of elements of $Map(S)$. One of the types of elements is called a pseudo-Anosov homeomorphism, which can be characterized by the hyperbolicity of the manifold associated with an element called a mapping torus. For a pseudo-Anosov element $f \in Map(S)$, Brock and Agol gave the upper bound for the volume of the mapping torus of f. Motivated by their results, we consider an end-periodic homeomorphism f for a certain infinite type surface S and the volume $V(f)$ of the convex core of the mapping torus of f. We give an upper bound on $V(f)$ in terms of the asymptotic translation length of f on the pants graph. This is a joint work with Elizabeth Field, Christopher Leininger, and Marissa Loving.

SIDDHI KRISHNA, Georgia Institute of Technology
[Wednesday June 9 / mercredi 9 juin, 12:30]
Taut foliations, Dehn surgery, and braid positivity

The L-space conjecture predicts a surprising relationship between the algebraic, geometric, and Floer-homological properties of a 3-manifold Y. In particular, it predicts exactly which 3-manifolds admit a "taut foliation". In this talk, I'll discuss some of my past and forthcoming work investigating these connections, with a view towards "braid positive knots" (i.e. the knots realized as the closure of positive braids). I'll focus on applications: in particular, I'll present some new obstructions to braid positivity, and a new unknot detector. No background in foliations or Floer homology theories will be assumed. All are welcome!

MARISSA LOVING, Georgia Institute of Technology-Main Campus
[Friday June 11 / vendredi 11 juin, 13:30]
Covers, Curves, and Length Spectra

I will share some of my ongoing work with Tarik Aougab, Max Lahn, and Nick Miller in which we explore the simple length spectrum rigidity of hyperbolic metrics arising from Sunada's construction. Along the way we give a characterization of equivalent covers (not necessarily regular) in terms of simple elevations of curves, generalizing previous work with Aougab, Lahn, and Xiao.

KATHRYN MANN, Cornell University
[Friday June 11 / vendredi 11 juin, 10:00]
Homeomorphisms of surfaces and the fine curve graph

In recent work, Bowden, Hensel and Webb studied a variant of the classical curve graph, whose vertices are all simple closed curves (not the classical version with curves up to isotopy!) In my talk I'll explain why this is a useful, object and describe new

joint work with the aforementioned BHW and Emmanuel Militon, that relates the dynamics of isotopically trivial homeomorphisms of the surface to the dynamics of their induced actions on this big curve graph, giving us new tools to study groups acting on surfaces.

DUNCAN MCCOY, UQAM
[Wednesday June 9 / mercredi 9 juin, 14:00]
Smoothing singularities vs definite fillings

There is a conjecture by Kollár that asserts that a large family of rational surface singularities admit a unique smoothing. Topologically speaking, a smoothing of a rational surface singularity corresponds to finding a negative definite 4-manifold filling the link of the singularity. It is natural, therefore, to wonder if one can establish a topological analogue of Kollár's conjecture by studying the negative definite manifolds fillings of these link singularities. I will discuss some joint work with Paolo Aceto and JungHwan Park relating to this question. No knowledge of singularity theory will be assumed.

INA PETKOVA, Dartmouth College
[Thursday June 10 / jeudi 10 juin, 12:30]
Annular link Floer homology and $\mathfrak{gl}_{1|1}$

The Reshetikhin-Turaev construction for the quantum group $U_q(\mathfrak{gl}_{1|1})$ sends tangles to $\mathbb{C}(q)$-linear maps in such a way that a knot is sent to its Alexander polynomial. Tangle Floer homology is a combinatorial generalization of knot Floer homology which sends tangles to (homotopy equivalence classes of) bigraded dg bimodules. In earlier work with Ellis and Vertesi, we show that tangle Floer homology categorifies a Reshetikhin-Turaev invariant arising naturally in the representation theory of $U_q(\mathfrak{gl}_{1|1})$; we further construct bimodules $\mathcal{E}$ and $\mathcal{F}$ corresponding to E, F in $U_q(\mathfrak{gl}_{1|1})$ that satisfy appropriate categorified relations. After a brief summary of this earlier work, I will discuss how the horizontal trace of the $\mathcal{E}$ and $\mathcal{F}$ actions on tangle Floer homology gives a $\mathfrak{gl}_{1|1}$ action on annular link Floer homology that has an interpretation as a count of certain holomorphic curves. This is based on joint work in progress with Andy Manion and Mike Wong.

WILL RUSHWORTH, McMaster
[Thursday June 10 / jeudi 10 juin, 13:00]
An application of link parity

Joint work with Hans Boden. Let D be a link diagram on an orientable surface Σ. A *parity* is a designation of the crossings of D as either *even* or *odd*, satisfying certain axioms.

Parity is a very useful tool in the study of knots in 3-manifolds of the form $\Sigma \times I$ (and related theories), but extending such methods to links of more than one component has proven to be difficult. We describe a new parity for a class of links in $\Sigma \times I$, and use it to prove a minimality result for link diagrams, generalizing a result of Manturov in the case of knot diagrams.

ANH TRAN, University of Texas at Dallas
[Wednesday June 9 / mercredi 9 juin, 13:30]
Classical pretzel knots and left-orderability

Heegaard Floer homology is a package of 3-manifold invariants introduced by Ozsvath and Szabo. Manifolds with minimal Heegaard Floer homology are called L-spaces. The L-space conjecture of Boyer, Gordon and Watson states that an irreducible rational homology 3-sphere is an L-space if and only if its fundamental group is not left-orderable. In this talk, we will discuss this conjecture for 3-manifolds obtained from the classical pretzel knots by Dehn surgeries.

HANNAH TURNER, University of Texas at Austin
[Wednesday June 9 / mercredi 9 juin, 10:30]
Branched cyclic covers and L-spaces

A 3-manifold is called an L-space if its Heegaard Floer homology is "simple." No characterization of all such "simple" 3-manifolds is known. Manifolds obtained as the double-branched cyclic cover of a knot in the 3-sphere give many examples of L-spaces. In this talk, I'll discuss the search for L-spaces among higher index branched cyclic covers of knots. In particular, I'll give new examples of knots whose branched cyclic covers are L-spaces for every index n. This is joint work with Ahmad Issa.

YVON VERBERNE, Georgia Institute of Technology
[Friday June 11 / vendredi 11 juin, 14:00]
The asymptotic dimension of big mapping class groups

In 2010, Bestvina-Bromberg-Fujiwara proved that the mapping class group of a finite-type surface has finite asymptotic dimension. In contrast, we will show the mapping class group of an infinite-type surface has infinite asymptotic dimension if it contains an essential shift. This work is joint with Curtis Grant and Kasra Rafi.

BIJI WONG, Max Planck Institute for Mathematics
[Thursday June 10 / jeudi 10 juin, 10:00]
d-invariants of double branched covers of links

Using Heegaard Floer homology, one can associate to a rational homology 3-sphere Y, equipped with a spin^c-structure $\mathfrak{s}$, a rational number, commonly referred to as the d-invariant of $(Y, \mathfrak{s})$. d-invariants have been useful in answering a range of questions in low-dimensional topology. A nice source of rational homology 3-spheres comes from considering double branched covers $\Sigma_2(K)$ of knots K in S^3. If $\Sigma_2(K)$ is an L-space, then the d-invariant of $\Sigma_2(K)$, at the unique spin-structure $\mathfrak{s}_0$, is well-understood: Lin-Ruberman-Saveliev in 2020 showed that it's a multiple of the signature of K.

When the branch set is a quasi-alternating link, the d-invariants of the double branched cover can be recovered from the signatures of the link in a similar way; this is due to Lisca-Owens in 2015. In this talk, we show that a similar phenomenon holds for branching over certain families of non-quasi-alternating links. This is work in progress with M. Marengon.

CLAUDIUS ZIBROWIUS, University of Regensburg
[Thursday June 10 / jeudi 10 juin, 10:30]
Khovanov homology and strong inversions

There is a one-to-one correspondence between strong inversions on knots in the three-sphere and a special class of four-ended tangles. I will discuss recent work with Artem Kotelskiy and Liam Watson in which we compute the reduced Khovanov homology of such tangles for all strong inversions on knots with up to 9 crossings [arXiv:2104.13592].

Mathematical modelling in epidemiology and public health
La modélisation mathématique en épidémiologie et en santé publique

Org: Hongbin Guo (Ottawa) and/et **Yanyu Xiao** (Cincinnati)

Schedule/Horaire

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12:30 - 13:00	James Watmouth (New Brunswick), *Case importation and community spread: controlling disease-spread in low density populations.* (p. 165)
13:00 - 13:30	Michael Li (Alberta), *Estimation of the Proportion of Population Infected by COVID-19: Mathematical Models as a Tool for Data Analysis* (p. 162)
13:30 - 14:00	Connell McCluskey (Wilfrid Laurier), *The effect of heterogeneity in social distancing* (p. 163)
16:00 - 16:30	Gerardo Chowell (Georgia State), *Forecasting the COVID-19 pandemic using ensemble modeling approaches* (p. 162)
16:30 - 17:00	Jianhong Wu (York), *A renewal equation model for disease transmission dynamics with contact tracing* (p. 166)
17:00 - 17:30	Muhammad Abu Shadeque Mullah and Ping Yan (Public Health Agency of Canada), *A Semi-parametric Mixed Model for Short-term Projection of Daily COVID-19 Incidence in Canada* (p. 164)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Gail Wolkowicz (McMaster), *A Delay Model for Persistent Viral Infections in Replicating Cells* (p. 165)
10:30 - 11:00	Zhisheng Shuai (Central Florida), *Impact of Hotspot Arrangements on Disease Invasion* (p. 164)
16:00 - 16:30	Xiaoying Wang (Trent), *Studying social awareness of physical distancing in mitigating COVID-19 transmission* (p. 165)
16:30 - 17:00	Yuming Chen (Wilfrid Laurier), *A new type function for constructing Lyapunov functions* (p. 162)
17:00 - 17:30	Fred Brauer (UBC), *Social distancing in epidemic models* (p. 161)
17:30 - 18:00	Felicia Magpantay (Queens), *Challenges in modeling the transition period of childhood diseases from the pre-vaccine to vaccine era* (p. 163)

Thursday June 10	**jeudi 10 juin**
10:00 - 10:30	Lin Wang (New Brunswick), *Impact of travel between patches on disease spread* (p. 164)
10:30 - 11:00	Aaron Lim (University of Bristol), *Modelling the impact and costs of hepatitis C virus screening and treatment scale-up to achieve elimination in Pakistan* (p. 163)
16:00 - 16:30	Jing Li (California State), *Modeling the waning and boosting of immunity from infection or vaccination* (p. 162)
16:30 - 17:00	Qiuyi Su (York), *Impact of variability of reproductive ageing and rate on childhood infectious disease prevention and control* (p. 164)
17:00 - 17:30	Stacey Smith ? (Ottawa), *Modelling the daily risk of Ebola in the presence and absence of a potential vaccine* (p. 164)

Abstracts/Résumés

FRED BRAUER, University of British Columbia
[Tuesday June 8 / mardi 8 juin, 17:00]
Social distancing in epidemic models

In an epidemic, especially an epidemic of a disease regarded as serious, some individuals change their behaviour in order to try to avoid becoming infected. A fraction of the population reduces the rate of contact with other individuals by a fraction. We examine how this affects the reproduction number of the epidemic. A similar approach may be used to estimate the effect of face mask usage by a fraction of the population.

This work is joint with Fan Bai, Hausdorff Institute for Mathematics, Bonn, Germany.

YUMING CHEN, Wilfrid Laurier University
[Tuesday June 8 / mardi 8 juin, 16:30]
A new type function for constructing Lyapunov functions

Lyapunov direct method is an effective method to determine the question about stability when it works. However, there exists no general approach for constructing the needed Lyapunov functions. In this talk, we provide a new type function to construct Lyapunov functions. When applied to an SI epidemic model with a nonlinear incidence, the obtained sufficient condition on the global stability of the endemic equilibrium is weaker than the one obtained by using the traditional Volterra-type function.

GERARDO CHOWELL, Georgia State University
[Monday June 7 / lundi 7 juin, 16:00]
Forecasting the COVID-19 pandemic using ensemble modeling approaches

The ongoing COVID-19 pandemic presents with an unprecedented opportunity to evaluate the performance of mathematical modeling frameworks for forecasting the trajectory of the pandemic at different spatial and temporal scales. I will discuss progress on developing new ensemble modeling approaches that can outperform individual models in short-term forecasts without substantially increasing model complexity.

JING LI, California State University Northridge
[Thursday June 10 / jeudi 10 juin, 16:00]
Modeling the waning and boosting of immunity from infection or vaccination

Immunity following natural infection or immunization may wane, increasing susceptibility to infection with time since infection or vaccination. Symptoms, and concomitantly infectiousness, depend on residual immunity. We quantify these phenomena in a model population composed of individuals whose susceptibility, infectiousness, and symptoms all vary with immune status. We also model age, which affects contact, vaccination, and possibly waning rates. The resurgences of pertussis that have been observed wherever effective vaccination programs have reduced typical disease among young children follow from these processes. As one example, we compare simulations with the experience of Sweden following resumption of pertussis vaccination after the hiatus from 1979 to 1996, reproducing the observations leading health authorities to introduce booster doses among school-aged children and adolescents in 2007 and 2014, respectively. Because pertussis comprises a spectrum of symptoms, only the most severe of which are medically attended, accurate models are needed to design optimal vaccination programs where surveillance is less effective.

MICHAEL LI, University of Alberta
[Monday June 7 / lundi 7 juin, 13:00]
Estimation of the Proportion of Population Infected by COVID-19: Mathematical Models as a Tool for Data Analysis

The COVID-19 has turned into one of the largest pandemics and public health crises in history, with close to 1 million daily cases world-wide by the end of April 2021, and a total death toll of more than 3 million and rising. During the COVID-19 pandemic, mathematical modeling has played a crucial role in informing public health responses and policy. In addition to its well-perceived function of predicting epidemic trends, mathematical models are also being used as an important tool for retrospective data analysis.

In this talk, I present our work using the SIR models to analyze the surveillance data and estimate the proportion of the population in Alberta that have been infected by SARS-CoV-2 during the first wave of the COVID-19. The estimation results have been validated by seroprevalence data. In addition, we are able to estimate the impact of social-distancing measures, the case-infection ratio, and the time dependent infection-fatality rate. A key step of the estimation process is to overcome the nonidentifiability problem in parameter estimation, which is a bottle-neck issue during model calibration from data. This is a collaboration between our research group and Alberta Health.

AARON LIM, University of Bristol
[Thursday June 10 / jeudi 10 juin, 10:30]
Modelling the impact and costs of hepatitis C virus screening and treatment scale-up to achieve elimination in Pakistan

Background and Aims: Pakistan has the world's second-largest hepatitis C virus (HCV) burden. The World Health Organization (WHO) HCV-elimination strategy advocates for a reduction in HCV incidence by 80% by 2030. We explore how this could be achieved and the costs of doing so in Pakistan.

Methods: A general population HCV transmission, screening, and treatment model was developed and calibrated using available data from Pakistan, incorporating cost data on diagnostics and HCV treatment. We modelled alternative strategies for scaling-up screening and HCV treatment to determine the resulting impact and costs of achieving the WHO HCV incidence target in Pakistan.

Results: One-time screening of 90% of the 2018 population by 2030, with 80% referral to treatment, leads to 14 million individuals being screened and 350,000 treated annually, decreasing incidence by 27% over 2018-2030. Prioritising screening to higher prevalence groups (people who inject drugs (PWID) and adults >30 years) and introducing re-screening (annually for PWID, otherwise 10-yearly) increases the number screened and treated by half and decreases incidence by 51%. Decreasing HCV incidence by 80% requires doubling the primary screening rate, increasing referral to 90%, re-screening the general population every 5-years, and re-engaging those lost-to-follow-up every 5-years. This could cost USD$8.1 billion, reducing to USD$3.9 billion with lowest costs for diagnostic tests and drugs, including healthcare savings, and implementing a simplified treatment algorithm. Further including societal benefits of gained productivity suggests that elimination can be cost-saving by 2030.

Discussion: HCV elimination can bring about substantial societal health and economic benefits for Pakistan.

FELICIA MAGPANTAY, Queen's University
[Tuesday June 8 / mardi 8 juin, 17:30]
Challenges in modeling the transition period of childhood diseases from the pre-vaccine to vaccine era

Mathematical models of childhood diseases often employ homogeneous time-dependent transmission rates. These models can provide good agreement with data in the absence of significant changes in population demography or levels of transmission, such as in the case of pre-vaccine era measles in industrialized countries. However, accurate modeling and forecasting of transient dynamics after the start of mass vaccination has proved more challenging. This is true even in the case of measles which has a well understood natural history and a very effective vaccine. Here, we demonstrate how the dynamics of homogeneous and age-structured models can be similar in the absence of vaccination, but diverge after vaccine roll-out. We also propose methods to fit such models to long term epidemiological data with imperfect covariate information.

CONNELL MCCLUSKEY, Wilfrid Laurier University
[Monday June 7 / lundi 7 juin, 13:30]
The effect of heterogeneity in social distancing

A compartmental model for COVID-19 with multiple subgroups that differ only in the level of contacts that members have with others was studied. Numerical simulations were performed for the case of two subgroups: one group that does social distancing and one that doesn't. The number of contacts for the social distancing group was varied, while keeping $\mathcal{R}_0$ fixed (by changing the relative sizes of the two groups). The peak number of infections changed dramatically, dropping by as much

as 70%, while the initial growth rate and timing of the peak remained constant. This suggests that heterogeneity in social distancing is fundamentally important.

In particular, if $\mathcal{R}_0$ is determined from a period of exponential growth without accounting for this heterogeneity, then the projections of future cases will be correspondingly affected.

MUHAMMAD ABU SHADEQUE MULLAH AND PING YAN, Public Health Agency of Canada he
[Monday June 7 / lundi 7 juin, 17:00]
A Semi-parametric Mixed Model for Short-term Projection of Daily COVID-19 Incidence in Canada

During a pandemic, data are very "noisy" with enormous amounts of local variation in daily counts, compared with any rapid changes in trend. Accurately characterizing the trends and reliable predictions on future trajectories are important for planning and public situation awareness. We describe a semi-parametric statistical model that is used for short-term predictions of daily counts of cases and deaths due to COVID-19 in Canada, which are routinely disseminated to the public by Public Health Agency of Canada. We present the model and the method. Performance indicators are defined and evaluated through extensive sensitivity analyses. We also compare our model with other commonly used models such as generalizations of logistic models (e.g. the Richards model and generalization) for similar purposes, followed by discussions on the limitations.

ZHISHENG SHUAI, University of Central Florida
[Tuesday June 8 / mardi 8 juin, 10:30]
Impact of Hotspot Arrangements on Disease Invasion

In this talk we consider the spread of an infectious disease in a heterogeneous environment, modeled as a network of patches. We focus on the invasibility of the disease, as quantified by the basic reproduction number R_0, and investigate how the locations of disease hotspots and the changes in the network structure affect the value of R_0. These effects can be characterized using new indices for the network average and network heterogeneity, and provide both qualitative and quantitative information for mitigating disease spread among the patches.

STACEY SMITH ?, The University of Ottawa
[Thursday June 10 / jeudi 10 juin, 17:00]
Modelling the daily risk of Ebola in the presence and absence of a potential vaccine

Ebola virus — one of the deadliest viral diseases, with a mortality rate around 90

QIUYI SU, York University
[Thursday June 10 / jeudi 10 juin, 16:30]
Impact of variability of reproductive ageing and rate on childhood infectious disease prevention and control

In this study, we propose a stage-structured model of childhood infectious disease transmission dynamics, with the population demographics dynamics governed by a certain family and population planning strategy giving rise to nonlinear feedback delayed effects on the reproduction ageing and rate. We first describe the long-term aging-profile of the population by describing the pattern and stability of equilibrium of the demographic model. Then we investigate the disease transmission dynamics, using the epidemic model when the population reaches the positive equilibrium (limiting equation). We establish conditions for the existence, uniqueness and global stability of the disease endemic equilibrium. We then prove the global stability of the endemic equilibrium for the original epidemic model with varying population demographics. The global stability of the endemic equilibrium allows us to examine the effects of reproduction ageing and rate, under different family planning strategies, on the childhood infectious disease transmission dynamics. We also examine demographic distribution, diseases reproductive number, infant disease rate and age distribution of disease.

LIN WANG, University of New Brunswick
[Thursday June 10 / jeudi 10 juin, 10:00]
Impact of travel between patches on disease spread

In this talk, I will present some results addressing the impacts of travel between patches on disease spread. We show that the impacts of travel are very complex and vary on model assumptions. This talk is based on several joint papers with my collaborators.

XIAOYING WANG, Trent University
[Tuesday June 8 / mardi 8 juin, 16:00]
Studying social awareness of physical distancing in mitigating COVID-19 transmission

Since the initial identification of a COVID-19 case in Wuhan, China, the novel disease quickly becomes a global pandemic emergency. In this paper, we propose a dynamic model that incorporates individuals' behavior change in social interactions at different stages of the epidemics. We fit our model to the data in Ontario, Canada and calculate the effective reproduction number $\mathcal{R}_t$ within each stage. Results show that $\mathcal{R}_t > 1$ if the public's awareness to practice physical distancing is relatively low and $\mathcal{R}_t < 1$ otherwise. Simulations show that a reduced contact rate between the susceptible and asymptomatic/unreported symptomatic individuals is effective in mitigating the disease spread. Moreover, sensitivity analysis indicates that an increasing contact rate may lead to a second wave of disease outbreak. We also investigate the effectiveness of disease intervention strategies. Simulations demonstrate that enlarging the testing capacity and motivating infected individuals to test for an early diagnosis may facilitate mitigating the disease spread in a relatively short time. Results also indicate a significantly faster decline of confirmed positive cases if individuals practice strict physical distancing even if restricted measures are lifted.

JAMES WATMOUTH, University of New Brunswick
[Monday June 7 / lundi 7 juin, 12:30]
Case importation and community spread: controlling disease-spread in low density populations.

For most of the pandemic, Canada has kept case numbers relatively low through a combination of community quarantine and travel restrictions. In theory, this has implications for how to approach and manage the new normal of endemic SARS-CoV-2. I will focus on what this might mean for Atlantic Canada, using simple SIR-type compartmental models with importation and waning immunity.

GAIL WOLKOWICZ, McMaster University
[Tuesday June 8 / mardi 8 juin, 10:00]
A Delay Model for Persistent Viral Infections in Replicating Cells

Persistently infecting viruses remain within infected cells for a prolonged period of time without killing the cells and can reproduce via budding virus particles or passing on to daughter cells after division. The ability for populations of infected cells to be long-lived and replicate viral progeny through cell division may be critical for virus survival in examples such as HIV latent reservoirs, tumor oncolytic virotherapy, and non-virulent phages in microbial hosts. We consider a model for persistent viral infection within a replicating cell population with time delay in the eclipse stage prior to infected cell replicative form. We obtain reproduction numbers that provide criteria for the existence and stability of the equilibria of the system and provide bifurcation diagrams illustrating transcritical (backward and forward), saddle-node, and Hopf bifurcations, and provide evidence of homoclinic bifurcations and a Bogdanov-Takens bifurcation. We investigate the possibility of long-term survival of the infection (represented by chronically infected cells and free virus) in the cell population by using the mathematical concept of robust uniform persistence. Using numerical continuation software with parameter values estimated from phage-microbe systems, we obtain two-parameter bifurcation diagrams that divide parameter space into regions with different dynamical

outcomes. We thus investigate how varying different parameters, including how the time spent in the eclipse phase, can influence whether or not the virus survives.

This is joint work with Hayriye Gulbudak and Paul Salceanu of the University of Louisiana, Lafayette

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JIANHONG WU, York University

[Monday June 7 / lundi 7 juin, 16:30]

A renewal equation model for disease transmission dynamics with contact tracing

Contact tracing is one of the most cost-effective and widely adopted non-pharmaceutical interventions to counteract the spread of infectious diseases in the absence of effective treatments and vaccines. We have developed a deterministic model for disease transmission dynamics, structured by time since infection, that includes diagnosis of symptomatic individuals and contact tracing. A mechanistic formulation of the processes at the individual level leads to an integral equation (delayed in calendar time and advanced in time since infection) for the probability that an infected individual is detected and isolated at any point in time. This is then coupled with a renewal equation for the total incidence to form a closed system describing the transmission dynamics involving contact tracing. When applied to the case of SARS-CoV-2, our results show that only combinations of diagnosis of symptomatic infections and contact tracing that are almost perfect in terms of speed or coverage can attain control, unless additional strong measures to reduce overall community transmission are in place. Under constraints on the testing or tracing capacity, the interruption of contact tracing may be irreversible and, depending on the overall growth rate and prevalence of the disease, may lead to outbreaks even in cases when the epidemic was initially under control. This is based on joint work with Francesca Scarabel and Lorenzo Pellis (University of Manchester, UK) and Nicholas H Ogden (PHAC, Public Health Agency of Canada).

Mathematical models for ecological dynamics
Modèles mathématiques en dynamiques écologiques

Org: Frithjof Lutscher (Ottawa) and/et **Olga Vasilyeva** (Memorial)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Christina Cobbold (Glasgow), *Impacts of range shifts for partially sedentary populations* (p. 167)
13:00 - 13:30	Mohammad El Smaily (University of Northern British Columbia), *Asymptotics and spectral properties of an integrodifference model with a discontinuous kernel* (p. 167)
13:30 - 14:00	Mark Lewis (University of Alberta), *Inside Dynamics for Integrodifference Equations* (p. 169)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:00	Maria Martignoni (UBC Okanagan), *Mathematical insights into mechanisms leading to coexistence and competitive exclusion among mutualist guilds* (p. 169)
13:00 - 13:30	Sana Jahedi (University of New Brunswick), *The equations of nature and the nature of equations* (p. 168)
13:30 - 14:00	Hao Wang (University of Alberta), *Optimal foraging strategies* (p. 170)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Samuel Fischer (University of Alberta), *Boosting propagule transport models with individual-specific data from mobile apps* (p. 168)
13:00 - 13:30	Yu Jin (Nebraska Lincoln), *Population dynamics in river networks* (p. 168)
13:30 - 14:00	Olga Vasilyeva (Memorial University), *Steady states of nonlinear reaction-diffusion-advection models: phase plane approach* (p. 170)
14:00 - 14:30	Xingfu Zou (Western), *Spatial-Temporal dynamics of diffusive Lotka-Volterra competition model with a shifting habitat* (p. 171)

Friday June 11	**vendredi 11 juin**
12:30 - 13:00	Xiaoying Wang (Trent University), *How spatial heterogeneity affects transient behavior in reaction-diffusion systems for ecological interactions* (p. 171)
13:00 - 13:30	Rebecca Tyson (UBC Okanagan), *Phase-sensitive tipping: New mechanism for extinction* (p. 170)
13:30 - 14:00	Frithjof Lutscher (UOttawa), *Transient dynamics for equilibrium and non-equilibrium communities* (p. 169)

Abstracts/Résumés

CHRISTINA COBBOLD, University of Glasgow

[Tuesday June 8 / mardi 8 juin, 12:30]

Impacts of range shifts for partially sedentary populations

Climate change is inducing range shifts for many species. In order to survive species must adapt or move to keep pace with their shifting range, but what does this mean for populations that are partially sedentary, with only a fraction of the population able to disperse ? In this talk we address this question using integrodifference equations. Using a combination of stability analysis and numerical simulation we show that, provided climate velocity is not too large, partially sedentary populations can outperform fully dispersing populations in one of two ways: (i) by persisting at climate speeds where a fully dispersing population cannot, and (ii) exhibiting higher population densities.

MOHAMMAD EL SMAILY, University of Northern British Columbia
[Tuesday June 8 / mardi 8 juin, 13:00]
Asymptotics and spectral properties of an integrodifference model with a discontinuous kernel

In this talk, we will show some analytic results we obtained for an integral equation modelling the discrete time dynamics of a population in a patchy landscape. Mathematically, the patchiness in the habitat is reflected in the discontinuity of the kernel of the integral operator, at a finite number of points in the whole domain. We prove that existence and uniqueness of a stationary state under certain assumptions on the principal eigenvalue of the linearized integral operator and the growth term as well. Under certain conditions the population undergoes extinction (in which case the stationary solution is 0 everywhere). This talk is from a joint work with Omar Abdul Halim.

SAMUEL FISCHER, Helmholtz Centre for Environmental Research – UFZ, Department of Ecological Modelling
[Thursday June 10 / jeudi 10 juin, 12:30]
Boosting propagule transport models with individual-specific data from mobile apps

Human traffic is an important vector for various invasive species and infectious diseases. Hence, modelling the dynamics of these species and diseases requires accurate estimates of human traffic flows. Such estimates are often computed using traffic models fitted to on-site or mail-out survey data. Recently, data collected via mobile apps have become a promising alternative, potentially allowing for more intricate traffic models incorporating numerous covariates and accounting for vectors' individual preferences. However, as potential vectors may not record all their trips, data voluntarily recorded via apps come with an additional level of uncertainty. We show how the benefits of app-based data can be exploited despite this drawback by accounting for repeating behaviour of vectors. We demonstrate our approach by considering a case study estimating angler traffic in Alberta, where anglers facilitate the spread of a parasite-induced fish disease. Our results do not only provide valuable insights into the traffic patterns of anglers in Alberta but also indicate that anglers' local preferences and their tendency to revisit previous destinations significantly affect traffic volumes between waterbodies. Ignoring these individual characteristics could lead to significant overestimates of vector traffic and propagule dispersal.

This work is joint with Pouria Ramazi, Sean Simmons, Mark Poesch, and Mark Lewis.

SANA JAHEDI, University of New Brunswick
[Wednesday June 9 / mercredi 9 juin, 13:00]
The equations of nature and the nature of equations

Systems of N equations in N unknowns are ubiquitous in mathematical modelling. These systems, often nonlinear, are used to identify equilibria of dynamical systems in ecology, genomics, control, and many other areas. Structured systems, where the variables that are allowed to appear in each equation are pre-specified, are especially common. For modeling purposes, there is a great interest in determining circumstances under which physical solutions exist, even if the coefficients in the model equations are only approximately known.

The structure of a system of equations can be described by a directed graph G that reflects the dependence of one variable on another, and we can consider the family $\mathcal{F}(G)$ of systems that respect G. We define a solution X of $F(X) = 0$ to be robust if for each continuous F^* sufficiently close to F, a solution X^* exists. Robust solutions are those that are expected to be found in real systems. There is a useful concept in graph theory called "cycle-coverable". We show that if G is cycle-coverable, then for "almost every" $F \in \mathcal{F}(G)$ in the sense of prevalence, every solution is robust. Conversely, when G fails to be cycle-coverable, each system $F \in \mathcal{F}(G)$ has no robust solutions.

Failure to be cycle-coverable happens precisely when there is a configuration of nodes that we call a "bottleneck," a criterion that can be verified from the graph. A "bottleneck" is a direct extension of what ecologists call the Competitive Exclusion Principle, but we apply it to all structured systems.

YU JIN, University of Nebraska-Lincoln
[Thursday June 10 / jeudi 10 juin, 13:00]
Population dynamics in river networks

Natural rivers connect to each other to form networks. The geometric structure of a river network can significantly influence spatial dynamics of populations in the system. We consider a process-oriented model to describe population dynamics in river networks of trees, establish the fundamental theories of the corresponding parabolic problems and elliptic problems, derive the persistence threshold by using the principal eigenvalue of the eigenvalue problem, and define the net reproductive rate to describe population persistence or extinction. By virtue of theoretical and numerical analyses, we investigate the effects of biotic and abiotic factors, especially the structure of the river network, the diffusion rate, and the flow velocity on population persistence in temporally constant or fluctuating environments.

MARK LEWIS, University of Alberta
[Tuesday June 8 / mardi 8 juin, 13:30]
Inside Dynamics for Integrodifference Equations

In this talk I will discuss recent modelling and analysis of integrodifference equation models for the asymptotic genetic structure of populations undergoing range expansion. To analyze the genetic consequences for long term population spread, we decompose the solution into neutral genetic components called neutral fractions. The "inside dynamics" then describe the spatiotemporal evolution of these neutral fractions. Extensions are made to include stage-structure in the population dynamics and mutations in the genetic fractions. This work is joint with Nathan Marculis and Roger Lui.

FRITHJOF LUTSCHER, University of Ottawa
[Friday June 11 / vendredi 11 juin, 13:30]
Transient dynamics for equilibrium and non-equilibrium communities

Asymptotically stable states continue to be the subject of study in most dynamical systems models in biology. However, true convergence to such states is rare in real systems. For example, human activities or natural events may perturb locally stable equilibrium communities. The study of transient dynamics attempts to gain information about the qualitative behaviour of dynamical systems before an asymptotically stable state is reached.

One particular question of transient dynamics asks how long a biological community will take to return to a stable steady state after a perturbation and how "far" from that state it may get in the process. To answer those questions, researchers have defined the "resilience" and "reactivity" of a system. For an appropriate choice of norms, these quantities can be measured in terms of eigenvalues of certain matrices. I will first review these measures and discuss some of the links to matrix analysis. Then I will suggest possible extensions of the theory to periodically forced systems and periodic orbits in autonomous systems and examine some of their properties.

MARIA MARTIGNONI, Memorial University
[Wednesday June 9 / mercredi 9 juin, 12:30]
Mathematical insights into mechanisms leading to coexistence and competitive exclusion among mutualist guilds

Mutualistic interactions are gaining increasing attention in the scientific literature, especially as pollination and plant-microbe symbioses play a key role in agricultural productivity. In particular, the widespread symbiosis between plants and arbuscular mycorrhizal (AM) fungi, offers a promising sustainable alternative for maintaining productivity in farmland. Despite the potential benefits for soil quality and crop yield associated with the use of AM fungi, experiments assessing the effective establishment of the fungi in the field have given inconsistent results. Additionally, it is not clear whether the introduction of commercial AM fungi could lead to a biodiversity loss in the native fungal community, and ultimately have a negative impact on plant growth. We developed a series of mathematical models for plant and AM fungal growth to assess the establishment, spread and

impact of an introduced species of AM fungi on the native fungal community and on plant productivity. Our models provide a theoretical framework to determine the circumstances under which the inoculated fungal species can coexist with the native fungal community and effectively boost productivity, versus when inoculation constitutes a biodiversity risk and, ultimately, a detriment to crop yield. Overall, our results show that diversity within mutualistic communities promotes productivity and reduces the risk of invasion and biodiversity loss posed by the introduction of a less mutualistic, or even parasitic, species. Although my analysis focuses on plant-fungal interactions, my findings provide valuable criteria to assess the impact of species introduction in mutualistic communities in general, such as other beneficial microbes or pollinator communities.

REBECCA TYSON, University of British Columbia Okanagan
[Friday June 11 / vendredi 11 juin, 13:00]
Phase-sensitive tipping: New mechanism for extinction

Global change is expected to lead to climate changes that include greater amplitudes and longer "periods" in climate variability. Many recent studies have noted that the greater variability associated with global change often has more impact than the change in average behaviour (temperature, precipitation, etc). In this paper we explore how changes in climate variability could interact with a system that is already oscillating, namely, predator-prey systems. We include an Allee effect in the prey equation so that we can determine whether or not extinction is deterministically possible, simply as a result of climatic variability. We find that variability-induced extinction is possible for both the Rosenzweig-MacArthur (RM) and Leslie-Gower-May (LGM) model systems and for realistic parameter values for the canada lynx and snowshoe hare.

Joint work with Hassan Alkhayuon, and Sebastian Wieczorek

OLGA VASILYEVA, Grenfell Campus, Memorial University of Newfoundland
[Thursday June 10 / jeudi 10 juin, 13:30]
Steady states of nonlinear reaction-diffusion-advection models: phase plane approach

Steady states of nonlinear reaction-diffusion-advection (RDA) models can be viewed as solutions of a system of two first order ODEs (subject to appropriate boundary conditions). Geometrically, they are represented by orbits in the phase plane, generated by the corresponding flow operator. In the basic case of a logistic RDA model describing population dynamics in a finite river segment, the phase plane approach helped to establish the existence and uniqueness of a positive steady state solution for sufficiently low advection speeds and sufficiently large domains. In this talk, I will discuss applications of the phase plane technique in two extensions of this basic model. In one setting, we increase the complexity of the habitat by considering a binary river network. In the second setting, we increase the complexity of the reaction term. Namely, we study an extension of the classical spatial spruce budworm (SBW) model (where reaction term accounts for predation), with advection term describing biased movement of larvae due to prevailing winds. In the river network case, the phase plane approach helps us to find conditions for existence and uniqueness of positive steady state. In the SBW model, we use phase plane analysis to determine the conditions for existence of the outbreak solutions. In particular, we observe that increasing advection can prevent outbreaks while allowing persistence in form of an endemic state. We obtain upper and lower bounds for the critical advection for outbreaks.

HAO WANG, University of Alberta
[Wednesday June 9 / mercredi 9 juin, 13:30]
Optimal foraging strategies

Nutritional constraints are common as food resources are rarely optimally suited for grazing species. Elemental mismatches between trophic levels can influence population growth and foraging behaviors. Grazing species, such as Daphnia, utilize optimal foraging techniques, such as compensatory feeding. Here, we develop two stoichiometric producer–grazer models, a base model that incorporates a fixed energetic foraging cost and an optimal foraging model where energetic foraging costs depend on food nutritional content. A variable energetic foraging cost results in cell quota-dependent predation behaviors. Analyzing and comparing these two models allows us to investigate the potential benefits of stoichiometric compensatory

foraging behaviors on grazer populations. Optimal foraging strategies depend on environmental conditions, such as light and nutrient availability. In low-light conditions, fixed energetic foraging appears optimal regardless of the nutrient loads. However, in higher light conditions and intermediate nutrient loads, grazers utilizing compensatory foraging strategies gain an advantage. Overall, grazers can benefit from compensatory feeding behaviors when the food nutrient content of their prey becomes low or high. At the end of the talk, I will briefly mention a discrete-time version in comparison with the continuous-time version.

XIAOYING WANG, Trent University
[Friday June 11 / vendredi 11 juin, 12:30]
How spatial heterogeneity affects transient behavior in reaction-diffusion systems for ecological interactions

Most studies of ecological interactions study asymptotic behavior, such as steady states and limit cycles. The transient behavior, i.e., qualitative aspects of solutions as and before they approach their asymptotic state, may differ significantly from asymptotic behavior. Understanding transient dynamics is crucial to predicting ecosystem responses to perturbations on short time scales. Several quantities have been proposed to measure transient dynamics in systems of ordinary differential equations. Here, we generalize these measures to reaction-diffusion systems in a rigorous way and prove various relations between the non-spatial and spatial effects, as well as an upper bound for transients. This extension of existing theory is crucial for studying how spatially heterogeneous perturbations and the movement of biological species involved affect transient behaviors. We illustrate several such effects with numerical simulations.

XINGFU ZOU, University of Western Ontario
[Thursday June 10 / jeudi 10 juin, 14:00]
Spatial-Temporal dynamics of diffusive Lotka-Volterra competition model with a shifting habitat

In this talk, I will report some recent results on the Spatial-temporal dynamics of some diffusive Lotka-Volterra competition models in an environment that worsens at a constant speed. Both random diffusion and nonlocal diffusion will be considered. Conditions for a species to be persistent or extinct, as well as the patterns of persistence and extinction will be discussed.

Modern Trends in Graph Theory
Tendances modernes de la théorie des graphes

Org: Bojan Mohar (Simon Fraser University) and/et **Sergey Norin** (McGill University)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Bojan Mohar (Simon Fraser University), *Many flows in the group connectivity setting* (p. 174)
10:30 - 11:00	Zdenek Dvorak (Charles University, Prague), *Fractional fragility* (p. 173)
12:30 - 13:00	Luke Postle (University of Waterloo), *Further progress towards Hadwiger's conjecture* (p. 175)
13:00 - 13:30	Sergey Norin (McGill University), *Fractional extremal function for graph minors* (p. 175)
13:30 - 14:00	Krystal Guo (University of Amsterdam), *Entanglement of free Fermions on distance-regular graphs* (p. 173)
14:00 - 14:30	Michelle Delcourt (Ryerson University), *Progress towards Nash-Williams' conjecture on triangle decompositions* (p. 172)
16:00 - 16:30	Bruce Richter (University of Waterloo), *Embedding Peano Spaces in Surfaces* (p. 175)
16:30 - 17:00	Joy Morris (University of Lethbridge), *Cop Numbers of Generalised Petersen Graphs* (p. 174)
17:00 - 17:30	Jeanette Janssen (Dalhousie University), *Reconstructing the linear order of a locally connected random graph* (p. 173)

Wednesday June 9	**mercredi 9 juin**
10:00 - 10:30	Daniel Kral (Masaryk University, Brno), *Uniform Turán density of 3-uniform hypergraphs* (p. 174)
10:30 - 11:00	Robert Samal (Charles University, Prague), *Random embeddings* (p. 176)
12:30 - 13:00	Pavol Hell (Simon Fraser University), *Signed graph homomorphism problems* (p. 173)
13:00 - 13:30	Mateja Sajna (University of Ottawa), *Finding Euler tours and Euler families in hypergraphs via edge cuts* (p. 175)
13:30 - 14:00	Gary MacGillivray (University of Victoria), *Structure of the SDR graph* (p. 174)
14:00 - 14:30	Peter Bradshaw (Simon Fraser University), *A rainbow connectivity threshold for random graph families* (p. 172)

Abstracts/Résumés

PETER BRADSHAW, Simon Fraser University
[Wednesday June 9 / mercredi 9 juin, 14:00]
A rainbow connectivity threshold for random graph families

Given a family $\mathcal{G}$ of graphs on a common vertex set X, we say that $\mathcal{G}$ is *rainbow connected* if for every vertex pair $u, v \in X$, there exists a path from u to v that uses at most one edge from each graph of $\mathcal{G}$. We consider the case that $\mathcal{G}$ contains s graphs, each sampled randomly from $G(n,p)$, with $n = |X|$ and $p = \frac{c \log n}{sn}$, where $c > 1$ is a constant. We show that there exists a threshold of at most three consecutive integer values such that when s is greater than or equal to this threshold, $\mathcal{G}$ is a.a.s. rainbow connected, and when s is below this threshold, $\mathcal{G}$ is a.a.s. not rainbow connected. This is joint work with Bojan Mohar.

MICHELLE DELCOURT, Ryerson University
[Tuesday June 8 / mardi 8 juin, 14:00]
Progress towards Nash-Williams' conjecture on triangle decompositions

Partitioning the edges of a graph into edge disjoint triangles forms a triangle decomposition of the graph. A famous conjecture by Nash-Williams from 1970 asserts that any sufficiently large, triangle divisible graph on n vertices with minimum degree at least 0.75 n admits a triangle decomposition. In the light of recent results, the fractional version of this problem is of central importance. A fractional triangle decomposition is an assignment of non-negative weights to each triangle in a graph such that the sum of the weights along each edge is precisely one.

We show that for any graph on n vertices with minimum degree at least 0.827327 n admits a fractional triangle decomposition. Combined with results of Barber, Kühn, Lo, and Osthus, this implies that for every sufficiently large triangle divisible graph on n vertices with minimum degree at least 0.82733 n admits a triangle decomposition. This is a significant improvement over the previous asymptotic result of Dross showing the existence of fractional triangle decompositions of sufficiently large graphs with minimum degree more than 0.9 n. This is joint work with Luke Postle.

ZDENEK DVORAK, Charles University
[Tuesday June 8 / mardi 8 juin, 10:30]
Fractional fragility

For a graph parameter f (for example treewidth), the fractional f-fragility gives a measure of a distance of a given graph from the graphs on which f is bounded. We survey some structural and algorithmic aspects of this concept.

KRYSTAL GUO, University of Amsterdam
[Tuesday June 8 / mardi 8 juin, 13:30]
Entanglement of free Fermions on distance-regular graphs

Many physical processes evolving over time on an underlying graph have led to problems in spectral graph theory, including quantum walks. These problems provide new graph invariants and also new applications for theorems about the eigenspaces of graphs. In this talk, we will consider free fermions on vertices of distance-regular graphs are considered. Using concepts from Terwilliger algebras, we study the entanglement Hamiltonian. This is based on joint work with Nicolas Crampé and Luc Vinet.

PAVOL HELL, Simon Fraser University
[Wednesday June 9 / mercredi 9 juin, 12:30]
Signed graph homomorphism problems

Each signed graph H defines a decision problem in which one has to decide if an input signed graph G admits a homomorphism to H. Because a signed graph is an equivalence class under re-signing, this is not exactly a constraint satisfaction problem, but it can be re-cast as an equivalent CSP problem, and hence these problems enjoy dichotomy of polynomial-time solvable versus NP-complete problems. I will discuss the precise classification in the case without lists (conjectured by Brewster, Foucaud, Naserasr and the speaker, and proved by Brewster and Siggers), as well as recent results by Kim and Siggers, and by the speaker jointly with Bok, Brewster, Feder and Jedličková, on the version with lists. Interesting questions remain open in the list version.

JEANETTE JANSSEN, Dalhousie University
[Tuesday June 8 / mardi 8 juin, 17:00]
Reconstructing the linear order of a locally connected random graph

Consider the following random graph process. Vertices are sampled from the interval $[0,1]$. Pairs of vertices are then connected (conditionally) independently with probability depending on their distance. Precisely, there is a decreasing function $f : [0,1] \to [0,1]$, the probability link function, and for a pair of vertices $x, y \in [0,1]$, the connection probability is $f(|x-y|)$. Since vertices

are embedded in the line segment, they have a natural ordering. Vertices that are closer to each other in the order are more likely to be connected ; thus most connections are local.

The problem we consider is that of retrieving this order from the sampled graph ; this may be referred to as graph seriation. We present a randomized graph seriation algorithm that, for a large class of probability functions, yields an ordering with error $O^*(\sqrt{n})$ with high probability ; we also show that this is the best-possible convergence rate for a large class of algorithms and proof strategies. Under an additional assumption on the probability function, we obtain the vastly better rate $O^*(n^\epsilon)$ for any $\epsilon > 0$.

This is joint work with Aaron Smith.

DANIEL KRAL, Masaryk University
[Wednesday June 9 / mercredi 9 juin, 10:00]
Uniform Turán density of 3-uniform hypergraphs

The uniform Turán density of a hypergraph H is the infimum of all d such that every sufficiently large hypergraph H_0 such that every linear size induced subhypergraph of H_0 has density at least d contains H as a subhypergraph. In addition to the classification of 3-uniform hypergraph with uniform Turán density equal to zero by Reiher, Rödl and Schacht [J. London Math. Soc. 97 (2018), 77-97], the only additional 3-uniform hypergraphs whose uniform Turán density is known are K_4^-. In this talk, we determine the uniform Turán density of several families of 3-uniform hypergraphs, in particular, we present a specific family of 3-uniform hypergraphs with uniform Turán density equal to $1/27$.

GARY MACGILLIVRAY, University of Victoria
[Wednesday June 9 / mercredi 9 juin, 13:30]
Structure of the SDR graph

The SDR graph of a collection S of sets is the graph whose vertices correspond to the systems of distinct representatives (SDRs) of S, and where two vertices are adjacent if the corresponding SDRs differ in the representative of exactly one set. The SDR graph is shown to be connected if and only if a Hall-like condition holds, and Hamilton connected when the number of different elements that appear in the sets is greater than twice the number of sets.

This is joint work with Stefan Bard.

BOJAN MOHAR, Simon Fraser University
[Tuesday June 8 / mardi 8 juin, 10:00]
Many flows in the group connectivity setting

Two well-known results in the world of nowhere-zero flows are Jaeger's 4-flow theorem asserting that every 4-edge-connected graph has a nowhere-zero $Z_2 \times Z_2$-flow and Seymour's 6-flow theorem asserting that every 2-edge-connected graph has a nowhere-zero Z_6-flow. These results were extended by Dvorak et al., proving the existence of exponentially many nowhere-zero flows under the same assumptions. We revisit this setting and provide extensions and simpler proofs of these results.

The concept of a nowhere-zero flow was extended in a significant paper of Jaeger, Linial, Payan, and Tarsi to a choosability-type setting. For a fixed abelian group Γ, an oriented graph $G = (V, E)$ is called Γ-*connected* if for every function $f : E \to \Gamma$ there is a flow $\phi : E \to \Gamma$ with $\phi(e) \neq f(e)$ for every $e \in E$ (note that taking $f = 0$ forces ϕ to be nowhere-zero). Jaeger et al. proved that every oriented 3-edge-connected graph is Γ-connected whenever $|\Gamma| \geq 6$. We prove that there are exponentially many solutions whenever $|\Gamma| \geq 8$. For the group Z_6 we prove that for every oriented 3-edge-connected $G = (V, E)$ with $\ell = |E| - |V| \geq 11$ and every $f : E \to Z_6$, there are at least $2^{\sqrt{\ell}/\log \ell}$ flows ϕ with $\phi(e) \neq f(e)$ for every $e \in E$.

This is joint work with Matt DeVos, Rikke Langhede, and Robert Samal.

JOY MORRIS, University of Lethbridge
[Tuesday June 8 / mardi 8 juin, 16:30]
Cop Numbers of Generalised Petersen Graphs

It was previously proved by Ball et al. (2015) that the cop number of any generalised Petersen graph is at most 4. I will present results that explain all of the known generalised Petersen graphs that actually have cop number 4, and that place them in the context of infinite families. A key consideration is the girth of the graph. This is based on joint work with Harmony Morris, Tigana Runte, and Adrian Skelton.

SERGEY NORIN, McGill University
[Tuesday June 8 / mardi 8 juin, 13:00]
Fractional extremal function for graph minors

The extremal function of a graph H is the supremum of ratios $|E(G)|/|V(G)|$ taken over non-null graphs G not containing H as a minor. In this talk we introduce a natural fractional variant of the extremal function and discuss its properties.

Based on joint work with Kevin Hendrey and David Wood.

LUKE POSTLE, University of Waterloo
[Tuesday June 8 / mardi 8 juin, 12:30]
Further progress towards Hadwiger's conjecture

In 1943, Hadwiger conjectured that every graph with no K_t minor is $(t-1)$-colorable for every $t \geq 1$. In the 1980s, Kostochka and Thomason independently proved that every graph with no K_t minor has average degree $O(t\sqrt{\log t})$ and hence is $O(t\sqrt{\log t})$-colorable. Recently, Norin, Song and I showed that every graph with no K_t minor is $O(t(\log t)^{\beta})$-colorable for every $\beta > 1/4$, making the first improvement on the order of magnitude of the $O(t\sqrt{\log t})$ bound. Here we show that every graph with no K_t minor is $O(t(\log t)^{\beta})$-colorable for every $\beta > 0$; more specifically, they are $O(t(\log\log t)^6)$-colorable.

BRUCE RICHTER, University of Waterloo
[Tuesday June 8 / mardi 8 juin, 16:00]
Embedding Peano Spaces in Surfaces

It is known that each surface S has a finite set F(S) of minimal finite graphs that do not embed in S. A Peano space is a topological space that is a continuous image of the unit interval. This is equivalent to being a locally connected, connected, compact metric space. We show that a Peano space P embeds in S if and only if P contains one of: a finite graph in F(S); a surface with Euler characteristic larger than that of S; or a generalization of the thumbtack space.

MATEJA SAJNA, University of Ottawa
[Wednesday June 9 / mercredi 9 juin, 13:00]
Finding Euler tours and Euler families in hypergraphs via edge cuts

An *Euler tour* of a hypergraph H is a closed walk that traverses each edge of H exactly once. The study of Euler tours in hypergraphs was initiated in a 2010 paper by Lonc and Naroski. These authors also proved that the problem of existence of an Euler tour in a general hypergraph (as well as in a 3-uniform hypergraph) is NP-complete. In a 2017 paper, Bahmanian and Šajna defined a relaxation of the concept of Euler tour, namely, *Euler family*, which is a collection of closed walks that jointly traverse each edge of the hypergraph exactly once, and showed that the problem of existence of an Euler family in a general hypergraph is polynomial.

In this talk, we show how the problem of existence of an Euler tour (family) in a hypergraph H can be reduced to the analogous problem in some smaller hypergraphs that are derived from H using an edge cut of H. In the process, new techniques of *edge cut assignments* and *collapsed hypergraphs* will be introduced. Moreover, we shall describe two divide-and-conquer-type algorithms based on these characterizations that construct an Euler tour (family) in a hypergraph if it exists.

This is joint work with Andrew Wagner.

ROBERT SAMAL, Charles University
[Wednesday June 9 / mercredi 9 juin, 10:30]
Random embeddings

An embedding of a connected graph on an orientable surface can be described (up to a homeomorphism) by providing a cyclic permutation for each vertex to describe the ordering of edges incident with the vertex. By choosing each of the permutations uniformly at random we get a random embedding of the given graph.

The study of random embeddings was started by Stahl and White in the 1990's, the main questions were the distribution of genus (equivalently, of the number of faces). The case of a multigraph with a single vertex and with two vertices was completely understood. We extend this to multistars, multigraphs where all edges are incident with a single vertex. We use Stanley's result on enumerating permutations to precisely bound the expected number of faces of a multistar. We apply this to get an estimate on the expected number of faces of a general graph in terms of its degeneracy. We also report on work-in-progress about getting a logarithmic bound on the expected number of faces of a complete graph.

Joint work with Jesse Campion Loth, Kevin Halasz, Tomáš Masařík, and Bojan Mohar.

New perspectives on the Brunn-Minkowski theory
Nouvelles perspectives sur la théorie de Brunn-Minkowski

Org: Alina Stancu (Concordia), **Deping Ye** (Memorial) and/et **Jiazu Zhou** (Southwest)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
9:00 - 9:30	Dongmeng Xi (Shanghai University), *The Brunn-Minkowski type inequalities and related Minkowski problems* (p. 181)
9:40 - 10:10	Jin Li (Vienna University of Technology), *Legendre transforms, Laplace transforms and valuations* (p. 179)
10:20 - 10:50	Ning Zhang (Huazhong University of Science and Technology), *Bodies with congruent conic sections or non-central sections in higher dimension* (p. 181)

Tuesday June 8	**mardi 8 juin**
9:00 - 9:30	Baocheng Zhu (Shaanxi Normal University), *The dual-polar Orlicz-Minkowski problems* (p. 182)
9:40 - 10:10	Elisabeth Werner (Case Western Reserve University), *Blaschke-Santalo inequality for many functions and geodesic barycenters of measures* (p. 180)
10:20 - 10:50	Steven Hoehner (Longwood University), *Extremal general affine surface areas* (p. 178)
12:30 - 13:00	Vladyslav Yaskin (University of Alberta), *A generalization of Winternitz's theorem and its discrete version* (p. 181)
13:10 - 13:40	Sudan Xing (University of Alberta), *On the Musielak-Orlicz-Gauss image problem* (p. 181)
13:50 - 14:20	Ping Zhong (University of Wyoming), *The Brown measures of free circular and multiplicative Brownian motions with nontrivial initial conditions* (p. 182)

Wednesday June 9	**mercredi 9 juin**
9:00 - 9:30	Yuxin Dong (Fudan University), *Prescribed Webster scalar curvatures on compact pseudo-Hermitian manifolds* (p. 178)
9:40 - 10:10	Han Hong (University of British Columbia), *Index estimate for free boundary CMC surfaces and isoperimetric problem* (p. 178)
10:20 - 10:50	Ben Li (Ningbo University) (p. 179)
12:30 - 13:00	Dmitry Ryabogin (Kent State University), *On the chord property for the pair of convex bodies* (p. 180)
13:10 - 13:40	Katheryna Tatarko (University of Alberta), *Unique determination of ellipsoids by their dual volumes* (p. 180)
13:50 - 14:20	Sergii Myroshnychenko (University of Alberta), *On visual shapes and non-central sections.* (p. 180)

Thursday June 10	**jeudi 10 juin**
9:00 - 9:30	Qingzhong Huang (Jiaxing University), *An anisotropic version of the Brezis-Van Schaftingen-Yung formula* (p. 178)
9:40 - 10:10	Dmitry Faifman (Tel Aviv University), *Between the Funk metric and convex geometry* (p. 178)
10:20 - 10:50	Youjiang Lin (Chongqing Business and Technology University), *Affine isoperimetric inequalities* (p. 179)
12:30 - 13:00	Oscar Ortega-Moreno (Technical University of Vienna), *Fixed points of Minkowski valuations* (p. 180)
13:10 - 13:40	Fabian Mussnig (University of Florence), *Functional Instrinsic Volumes and Hadwiger's Theorem for Convex Functions* (p. 179)
13:50 - 14:20	Jie Xiao (Memorial University), *A Planar Minkowski Problem for the Electrostatic Capacity* (p. 181)

Friday June 11	**vendredi 11 juin**
9:00 - 9:30	Carsten Schuett (Christian-Albrechts-Universität Kiel) (p. 180)
9:40 - 10:10	Arnaud Marsiglietti (University of Florida), *Concavity properties of the outer parallel volume* (p. 179)

10:20 - 10:50 Galyna Livshyts (Georgia Institute of Technology) (p. 179)

Abstracts/Résumés

YUXIN DONG, School of Mathematical Sciences, Fudan University, P. R. China
[Wednesday June 9 / mercredi 9 juin, 9:00]
Prescribed Webster scalar curvatures on compact pseudo-Hermitian manifolds

In this talk, we will discuss the problem of prescribing Webster scalar curvatures on compact strictly pseudoconvex CR manifolds. In terms of the upper and lower solutions method and the perturbation theory of self-adjoint operators, we try to describe some sets of Webster scalar curvature functions which can be realized through pointwise CR conformal deformations and CR conformally equivalent deformations respectively from a given pseudo-Hermitian structure. This is a joint work with Yibin Ren and Weike Yu.

DMITRY FAIFMAN, Tel Aviv University
[Thursday June 10 / jeudi 10 juin, 9:40]
Between the Funk metric and convex geometry

The Funk metric is a non-symmetric relative of the Hilbert metric in the interior of a convex body ; in some sense it interpolates between Minkowski geometry and centro-affine geometry. I will present some results concerning the Holmes-Thompson volume in Funk geometry. In particular, we will see generalizations of some well-known inequalities on the volume product in convex geometry, such as the Blaschke-Santalo inequality and the Mahler conjecture.

STEVEN HOEHNER, Longwood University
[Tuesday June 8 / mardi 8 juin, 10:20]
Extremal general affine surface areas

Recently, Giladi, Huang, Schütt and Werner (2020) introduced and studied the extremal L_p affine surface areas. We extend their definitions and some of their results from the setting of p-affine surface areas to the setting of general L_φ and L_ψ affine surface areas, where φ and ψ are concave and convex functions which satisfy some prescribed conditions. We also prove Blaschke-Santaló type inequalities for these new extremal affine surface areas.

HAN HONG, University of British Columbia
[Wednesday June 9 / mercredi 9 juin, 9:40]
Index estimate for free boundary CMC surfaces and isoperimetric problem

Let Ω be a bounded domain in $\mathbb{R}^3$, the isoperimetric problem asks: what is the surface in Ω that has least area under fixed volume constraint ? The existence of such surface is guaranteed and it must be free boundary constant mean curvature surfaces. We will discuss the geometry and topology of such surfaces Σ. In particular, we will give a lower bound for the Morse index:

$$\mathrm{Index}_w(\Sigma) \geq \frac{2g + r - 4}{6}$$

where g, r are the number of genus and boundary components of the surface, respectively.

QINGZHONG HUANG, Jiaxing University
[Thursday June 10 / jeudi 10 juin, 9:00]
An anisotropic version of the Brezis-Van Schaftingen-Yung formula

Very recently, Brezis, Van Schaftingen and Yung established a surprising formula which connects the Marcinkiewicz quasi-norm and the Sobolev semi-norm. In this talk, I will present an anisotropic version of the Brezis-Van Schaftingen-Yung formula.

BEN LI, Ningbo University
[Wednesday June 9 / mercredi 9 juin, 10:20]

JIN LI, Vienna University of Technology
[Monday June 7 / lundi 7 juin, 9:40]
Legendre transforms, Laplace transforms and valuations

Beautiful characterizations of Legendre transforms via the concept of duality were established by Artstein-Avidan and Milman [Ann. of Math. 2009]. One of the key points in their arguments is that dualities are "strong" valuations, namely, the maximum and the "minimum" of convex functions are interchanged by dualities. In this talk, I will present some characterizations of Legendre transforms via the concept of valuation and affine "invariance". Laplace transforms can be also characterized by similar properties. Hence we may say that Legendre transforms and Laplace transforms are siblings.

YOUJIANG LIN, Chongqing Technology and Business University
[Thursday June 10 / jeudi 10 juin, 10:20]
Affine isoperimetric inequalities

In this talk, we state some basic concepts of convex geometry analysis and give the proofs of the functional versions of the affine isoperimetric inequalities, i.e., Orlicz-Polya-Szego inequalities with respect to log-concave functions, Sobolev functions and BV functions.

GALYNA LIVSHYTS, Georgia Institute of Technology
[Friday June 11 / vendredi 11 juin, 10:20]

ARNAUD MARSIGLIETTI, University of Florida
[Friday June 11 / vendredi 11 juin, 9:40]
Concavity properties of the outer parallel volume

We investigate concavity properties of the outer parallel volume of compact sets, and discuss the relationship with important geometric inequalities such as the Brunn-Minkowski and isoperimetric inequalities.

FABIAN MUSSNIG, University of Florence
[Thursday June 10 / jeudi 10 juin, 13:10]
Functional Instrinsic Volumes and Hadwiger's Theorem for Convex Functions

In recent years, many results from the classical Brunn-Minkowski theory have been transfered to the functional setting. In this talk I am going to present a new class of functional intrinsic volumes for convex functions and discuss their properties. Among

the many features they share with their classical counterparts is the fact that they can be characterized as continuous rigid motion invariant valuations. The results of this talk are joint work with Andrea Colesanti and Monika Ludwig.

SERGII MYROSHNYCHENKO, University of Alberta
[Wednesday June 9 / mercredi 9 juin, 13:50]
On visual shapes and non-central sections.

Assume that Earth is made out of a transparent glass and contains a convex body K in its interior. Let K be seen as a disk from every point on the planet's surface, possibly of different radii. Can one conclude that K is a Euclidean ball? What if it is seen as an ellipse or a polygon?

We discuss related open problems, provide known and recent results that answer all of the questions above, as well as their dual counterparts for non-central sections of convex bodies.

OSCAR ORTEGA-MORENO, Vienna University of Technology
[Thursday June 10 / jeudi 10 juin, 12:30]
Fixed points of Minkowski valuations

In this talk, we show that for any sufficiently regular even Minkowski valuation Φ which is homogeneous and intertwines rigid motions, there exists a neighborhood of the unit ball, where balls are the only solutions to the fixed-point problem $\Phi^2 K = \alpha K$. This significantly generalizes results by Ivaki for projection bodies and suggests, via the Lutwak–Schneider class reduction technique, a new approach to Petty's conjectured projection inequality. This is joint work with Franz E. Schuster.

DMITRY RYABOGIN, Kent State University
[Wednesday June 9 / mercredi 9 juin, 12:30]
On the chord property for the pair of convex bodies

Let K be a convex body in $\mathbb{R}^d$, $d \geq 3$, and let K_δ be its floating body for some fixed $\delta \in \left(0, \frac{\mathrm{vol}_d(K)}{2}\right)$. Assume that for all sections $K \cap H$ that are tangent to K_δ, the length of all the chords $g \subset K \cap H$ passing through the centers of mass of all $K \cap H$ is the same. Does it follow that K and K_δ are concentric Euclidean balls? We show that the answer is affirmative for bodies of revolution.

CARSTEN SCHUETT, Christian-Albrechts-Universität Kiel
[Friday June 11 / vendredi 11 juin, 9:00]

KATHERYNA TATARKO, University of Alberta
[Wednesday June 9 / mercredi 9 juin, 13:10]
Unique determination of ellipsoids by their dual volumes

Gusakova and Zaporozhets conjectured that ellipsoids in $\mathbb{R}^n$ are uniquely determined up to an isometry by their intrinsic volumes. In this talk, we will present a solution to the dual problem in all dimensions. We show that an ellipsoid is uniquely determined up to an isometry by its dual Steiner polynomial. We also discuss an alternative proof of the analogous known result of Petrov and Tarasov for classical Steiner polynomials in $\mathbb{R}^3$. This is joint work with S. Myroshnychenko and V. Yaskin.

ELISABETH WERNER, Case Western Reserve University
[Tuesday June 8 / mardi 8 juin, 9:40]
Blaschke-Santalo inequality for many functions and geodesic barycenters of measures

We prove a natural generalization of the Blaschke-Santalo inequality and the affine isoperimetric inequalities for many sets and many functions. We derive from it an entropy bound for the total Kantorovich cost appearing in the barycenter problem.

Based on joint work with Alexander V. Kolesnikov.

DONGMENG XI, Shanghai University
[Monday June 7 / lundi 7 juin, 9:00]
The Brunn-Minkowski type inequalities and related Minkowski problems

In this talk, we will introduce our recent works on the (dual) Brunn-Minkowski inequalities, and related Minkowski problems. These works are jointed with Yong Huang, Hailin Jin, Gangsong Leng, Yuchi Wu, Zhenkun Zhang, and Yiming Zhao.

JIE XIAO
[Thursday June 10 / jeudi 10 juin, 13:50]
A Planar Minkowski Problem for the Electrostatic Capacity

This talk will address the existence-uniqueness-regularity of a planar Minkowski problem for the electrostatic capacity.

SUDAN XING, University of Alberta
[Tuesday June 8 / mardi 8 juin, 13:10]
On the Musielak-Orlicz-Gauss image problem

For a convex body K, its Musielak-Orlicz-Gauss image measure, denoted by $\widetilde{C}_{\Theta}(K,\cdot)$, involves a triple $\Theta=(G,\Psi,\lambda)$ where G and Ψ are two Musielak-Orlicz functions defined on $S^{n-1}\times(0,\infty)$ and λ is a nonzero finite Lebesgue measure on the unit sphere S^{n-1}. Such a measure can be produced by a variational formula of $\widetilde{V}_{G,\lambda}(K)$ (the general dual volume of K with respect to λ) under the perturbations of K by the Musielak-Orlicz addition defined via the function Ψ. The Musielak-Orlicz-Gauss image problem contains many intensively studied Minkowski type problems and the recent Gauss image problem as its special cases. Under the condition that $G(\cdot,\cdot)$ is decreasing on its second variable, the existence of solutions to this problem is established. This talk is based on a joint work with Dr. Qingzhong Huang, Deping Ye and Baocheng Zhu.

VLADYSLAV YASKIN, University of Alberta
[Tuesday June 8 / mardi 8 juin, 12:30]
A generalization of Winternitz's theorem and its discrete version

Let K be a convex body in the plane. Cut K by a line passing through its centroid. It is a well-known result, due to Winternitz, that the areas of the resulting two pieces are at least $4/9$ times the area of K. We will discuss a discrete version of Winternitz's theorem. Joint work with Alexandra Shyntar.

NING ZHANG, Huazhong University of Science and Technology
[Monday June 7 / lundi 7 juin, 10:20]
Bodies with congruent conic sections or non-central sections in higher dimension

In this talk, we will present a recent work with Jun-Ling Li. We show that C^2 convex bodies in R^n with congruent conic sections or non-central sections will coincide. Using the continuity of multivalued function, this gives a solution to different types of Suss conjecture.

PING ZHONG, University of Wyoming
[Tuesday June 8 / mardi 8 juin, 13:50]
The Brown measures of free circular and multiplicative Brownian motions with nontrivial initial conditions

Free probability theory is a noncommutative version of probability theory based on free independence. Free random variables can be viewed as limit objects of certain random matrices. The limits of matrix-valued Brownian motions are described as various Brownian motions in the framework of free probability.

I will discuss briefly a joint work with CW Ho on the Brown measures of free Brownian motions with certain nontrivial initial conditions, where the subordination functions played a key role. The famous circular law (due to Ginibre, Girko, Bai, Tao, Vu and many others) states that n by n square random matrices with independent and i.i.d. entries that have mean zero and variance $1/n$ convergences to the uniform distribution on the unit disk as the size n tends to infinity. Our result for circular Brownian motion provides a density formula for the candidate of the limit operator of those random matrices perturbed by any deterministic Hermitian matrices that converge to some limit. The multiplicative version of this result extends a recent result of Driver-Hall-Kemp where they used some novel PDE methods to calculate the Brown measure of the free multiplicative Brownian motion with identity as the initial condition.

BAOCHENG ZHU, Shaanxi Normal University
[Tuesday June 8 / mardi 8 juin, 9:00]
The dual-polar Orlicz-Minkowski problems

We will talk about the dual-polar Orlicz-Minkowski problems: under what conditions on a nonzero finite measure μ and a continuous function $\varphi : (0,\infty) \to (0,\infty)$ there exists a convex body $K \in \mathcal{K}_o^n$ such that K is an optimizer of the following optimization problems:

$$\inf / \sup \left\{ \int_{S^{n-1}} \varphi(h_L) d\mu : L \in \mathcal{K}_o^n \right\} ?$$

Where h_L is the support function of L and S^{n-1} is the unit sphere. The solvability of the dual-polar Orlicz-Minkowski problems is discussed under different conditions. In particular, under certain conditions on φ, the existence of a solution is proved for a nonzero finite measure μ on S^{n-1} which is not concentrated on any hemisphere of S^{n-1}.

Noncommutative Geometry and Mathematical Physics
Géométrie non commutative et physique mathématique

Org: **Branimir Cacic** (UNB) and/et **Masoud Khalkhali** (UWO)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Remus Floricel (Regina), *Inductive limits of spectral triples* (p. 184)
10:30 - 11:00	Heath Emerson (Victoria), *Noncommutative geometry and Kronecker flow* (p. 183)
12:30 - 13:00	Raphael Ponge (Sichuan), *Dixmier trace formulas and negative eigenvalues of Schrödinger operators on noncommutative tori.* (p. 185)
13:00 - 13:30	Karen Strung (Czech Academy of Sciences), *Positive line bundles over the irreducible quantum flag manifolds* (p. 185)
13:30 - 14:00	Luuk Verhoeven (Western), *Embedding spheres into Euclidean space using unbounded Kasparov products* (p. 185)
14:00 - 14:30	Nathan Pagliaroli (Western), *Phase Transition in Random Noncommutative Geometries* (p. 184)

Thursday June 10	**jeudi 10 juin**
10:00 - 10:30	Marco de Cesare (Basque University), *Noncommutative spacetime and bimetric gravity* (p. 183)
10:30 - 11:00	Shane Farnsworth (Max Planck Institute for Gravitational Physics), *'Jordan' nonassociative geometry and gauge theory* (p. 184)
12:30 - 13:00	Andrzej Sitarz (Jagiellonian University), *Models of products of noncommutative geometries.* (p. 185)
13:00 - 13:30	Latham Boyle (Perimeter) (p. 183)
13:30 - 14:00	Ilya Shapiro (Windsor), *Relative Hopf-cyclic cohomology* (p. 185)
14:00 - 14:30	Hamed Hessam (Western), *Bootstrapping Random Noncommutative Geometries* (p. 184)

Friday June 11	**vendredi 11 juin**
10:00 - 10:30	Marcelo Laca (Victoria), *Low-temperature spectroscopy for number fields* (p. 184)
10:30 - 11:00	Therese-Marie Landry (UC Riverside) (p. 184)

Abstracts/Résumés

LATHAM BOYLE, Perimeter
[Thursday June 10 / jeudi 10 juin, 13:00]

MARCO DE CESARE, University of the Basque Country UPV/EHU
[Thursday June 10 / jeudi 10 juin, 10:00]
Noncommutative spacetime and bimetric gravity

I will present an extension of general relativity based on a twist-deformed spacetime and discuss its connections with bimetric gravity.

HEATH EMERSON, University of Victoria
[Tuesday June 8 / mardi 8 juin, 10:30]
Noncommutative geometry and Kronecker flow

We discuss a class of spectral triples over irrational rotation algebras going back to early work of Connes and more recent work of Lesch and Moscovici. We employ a slightly different construction and produce (new) examples of topologically nontrivial spectral triples over $C(\mathbb{T}^2) \rtimes \Lambda$ for Λ the (dense) subgroup of R generated by the integers and the slope θ of a Kronecker flow on $\mathbb{T}^2$. These triples have the meromorphic extension property if θ satisfies a Diophantine condition. We discuss applications to the KK-theory of A_θ and generalizations in progress to lattice pairs in $\mathbb{R}^n$.

SHANE FARNSWORTH, Max-Planck Institute for Gravitational Physics, Germany
[Thursday June 10 / jeudi 10 juin, 10:30]
'Jordan' nonassociative geometry and gauge theory

In this talk I will discuss the construction of gauge theories as 'Jordan' nonassociative geometries, and discuss the way in which these constructions relate to the analogous picture in noncommutative geometry.

REMUS FLORICEL, University of Regina
[Tuesday June 8 / mardi 8 juin, 10:00]
Inductive limits of spectral triples

We discuss several necessary and sufficient conditions for the existence of inductive limits of spectral triples, and illustrate these conditions with a few examples. This is based on joint work with A. Ghorbanpour.

HAMED HESSAM, Western University
[Thursday June 10 / jeudi 10 juin, 14:00]
Bootstrapping Random Noncommutative Geometries

In this talk we will see a technique called bootstraps can be applied to find the moments of a single matrix and two-matrix models taken from finite noncommutative geometries. We will discuss the relationships between the order parameter of the model and the second moment. From there all other moments are able to be expressed as in terms of the order parameter and the second moment, allowing them to be computed. This work is based on the joint paper of mine with Masoud Khalkhali and Nathan Pagliaroli.

MARCELO LACA, University of Victoria
[Friday June 11 / vendredi 11 juin, 10:00]
Low-temperature spectroscopy for number fields

We establish, in the context of general C*-dynamical systems, a precise way to associate partition functions to extremal KMS states that are of type I. The study is motivated by low-temperature phase transitions exhibited by certain C*-dynamical systems that arise from number fields, which do not have intrinsic Hamiltonians because their observed absorption spectra varies depending on the equilibrium configuration. However, the resulting collection of partition functions can be used as an invariant for number fields and congruence monoids. This is joint work with Chris Bruce and Takuya Takeishi.

THERESE-MARIE LANDRY, UC Riverside
[Friday June 11 / vendredi 11 juin, 10:30]

NATHAN PAGLIAROLI, Western University
[Tuesday June 8 / mardi 8 juin, 14:00]
Phase Transition in Random Noncommutative Geometries

Finite spectral triples where the algebra is the space of N by N Hermitian matrices are an example of a matrix geometry. Such spaces can be equipped with a probability measure on the moduli space of its Dirac operator creating ensembles of Dirac operators. Numerical evidence has shown that these ensembles exhibit evidence of phase transition as well as the spectrum being related to that of the fuzzy 2-sphere. In this talk we will discuss a proof of the existence of phase transitions in certain Dirac ensembles as well as how to compute their spectral density function. This work is based on the joint paper of mine with Masoud Khakhali arXiv:2006.02891.

RAPHAEL PONGE, Sichuan University
[Tuesday June 8 / mardi 8 juin, 12:30]
Dixmier trace formulas and negative eigenvalues of Schrödinger operators on noncommutative tori.

This talk has two main results. The first result is an extension of Connes' integration formula to noncommutative tori equipped with general Riemannian metrics. The second main result is a version for noncommutative tori of the Cwikel-Lieb-Rozenblum inequality for negative eigenvalues of Schrödinger operators on noncommutative tori. This leads to conjecture a semiclassical Weyl's law for noncommutative tori. This shows that we can do Riemannian geometry in a quantum setting. Both results are consequences of a new version of Cwikel estimates for weak Schatten classes. This is joint work with Edward McDonald (UNSW-Sydney, Australia).

ILYA SHAPIRO, University of Windsor
[Thursday June 10 / jeudi 10 juin, 13:30]
Relative Hopf-cyclic cohomology

Motivated by the need to extend the definition of anti-Yetter-Drinfeld modules for Hopf algebras in symmetric categories to the more general braided categories we realize that the question is ill-posed. What one has instead is a localization of the usual coefficients.

ANDRZEJ SITARZ, Jagiellonian University
[Thursday June 10 / jeudi 10 juin, 12:30]
Models of products of noncommutative geometries.

Models of noncommutative geometry that are products of manifolds with discrete spaces, which have Dirac operators that are not of product type, lead to interesting physical theories in the gravity and particle sectors. The gravity construction appears to be similar to the bimetric gravity modifications whereas the nonproduct structure applied to the description of the Standard Model leads to no fermion doubling with explicit CP breaking and additional topological terms.

KAREN STRUNG, Institute of Mathematics, Czech Academy of Sciences
[Tuesday June 8 / mardi 8 juin, 13:00]
Positive line bundles over the irreducible quantum flag manifolds

Noncommutative Kähler structures were recently introduced by Ó Buachalla as a framework for studying noncommutative Kähler geometry on quantum homogeneous spaces. The notion of a positive vector bundle directly generalises to this setting. For covariant Kähler structures of irreducible type (those having an irreducible space of holomorphic 1-forms) we provide simple cohomological criteria for positivity, offering a means to avoid explicit curvature calculations. These general results are applied to our motivating family of examples, the irreducible quantum flag manifolds $O_q(G/L_S)$. Building on the recently established noncommutative Borel-Weil theorem, every covariant line bundle over $O_q(G/L_S)$ can be identified as positive, negative, or flat, and hence we can conclude that each Kähler structure is of Fano type. This is joint work with Díaz García, Ó Buachalla, Krutov, and Somberg.

LUUK VERHOEVEN, University of Western Ontario
[Tuesday June 8 / mardi 8 juin, 13:30]
Embedding spheres into Euclidean space using unbounded Kasparov products

We construct an unbounded representative for the shriek class associated to the embeddings of spheres into Euclidean space. We equip this unbounded KK-cycle with a connection and compute the unbounded Kasparov product with the Dirac operator on $\mathbb{R}^{n+1}$. We find that the resulting spectral triple for the algebra $C(S^n)$ differs from the Dirac operator on the round sphere by a so-called index cycle, whose class in $KK_0(\mathbb{C};\mathbb{C})$ represents the multiplicative unit. At all points we check that our construction involving the unbounded Kasparov product is compatible with the bounded Kasparov product using Kucerovsky's criterion and we thus capture the composition law for the shriek map for these immersions at the unbounded KK-theoretical level, while retaining the geometric information. The end goal of this project will be to generalize this construction to arbitrary immersions of manifolds.

Nonlinear analysis on manifolds
Analyse non linéaire dans les variétés différentielles

Org: Siyuan Lu (McMaster) and/et **Jérôme Vétois** (McGill)

Schedule/Horaire

Monday June 7 — **lundi 7 juin**

12:30 - 13:20	Spyros Alexakis (University of Toronto) (p. 188)
16:00 - 16:20	Han Hong (University of British Columbia), *Stability and index estiamtes of capillary surfaces* (p. 189)
16:30 - 16:50	Siyi Zhang (University of Notre Dame), *Conformally invariant rigidity theorems on four-manifolds with boundary* (p. 193)
17:00 - 17:20	Fengrui Yang (McGill University), *Prescribed curvature measure problem in hyperbolic space* (p. 193)

Tuesday June 8 — **mardi 8 juin**

10:00 - 10:50	Robert Haslhofer (University of Toronto), *Mean curvature flow through neck-singularities* (p. 189)
12:30 - 13:20	Alex Mramor (Johns Hopkins University), *On the unknottedness of self shrinkers* (p. 191)
13:30 - 14:20	Beomjun Choi (University of Toronto), *Liouville theorem for surfaces translating by sub-affine-critical powers of Gauss curvature* (p. 188)
16:00 - 16:20	Keaton Naff (Columbia University), *A local noncollapsing estimate for mean curvature flow* (p. 191)
16:30 - 16:50	Christopher Kennedy (University of Toronto), *A Bochner Formula on Path Space for the Ricci Flow* (p. 189)
17:00 - 17:20	Yangyang Li (Princeton University), *Generic Regularity of Minimal Hypersurfaces in Dimension 8* (p. 190)

Wednesday June 9 — **mercredi 9 juin**

10:00 - 10:50	Pengfei Guan (McGill University), *Locally constrained mean curvature type flows* (p. 189)
12:30 - 13:20	Xiangwen Zhang (University of California Irvine), *A geometric flow for Type IIA superstrings* (p. 194)
13:30 - 14:20	Sébastien Picard (University of British Columbia), *Topological Transitions of Calabi-Yau Threefolds* (p. 191)
16:00 - 16:20	Jiewon Park (California Institute of Technology), *The Laplace equation on noncompact Ricci-flat manifolds* (p. 191)
16:30 - 16:50	Vladmir Sicca (McGill University), *A prescribed scalar and boundary mean curvature problem on compact manifolds with boundary* (p. 192)

Thursday June 10 — **jeudi 10 juin**

10:00 - 10:50	Frédéric Robert (Université de Lorraine), *Blowing-up solutions for second-order critical elliptic equations: the impact of the scalar curvature* (p. 192)
12:30 - 13:20	Juncheng Wei (University of British Columbia), *Sharp quantitative estimates for Struwe's decomposition* (p. 193)
13:30 - 14:20	Bruno Premoselli (Université Libre de Bruxelles), *Towers of bubbles for Yamabe-type equations in dimensions larger than 7* (p. 192)
16:00 - 16:20	Hussein Mesmar (Université de Lorraine, France), *Solution for Hardy-Sobolev equation in presence of isometrie* (p. 190)
16:30 - 16:50	Hussein Cheikh-Ali (Universite Libre de Bruxelles), *The second best constant for the Hardy-Sobolev inequality on manifolds* (p. 188)
17:00 - 17:20	Edward Chernysh (McGill University), *A global compactness theorem for critical p-Laplace equations with weights* (p. 188)

Friday June 11 — **vendredi 11 juin**

10:00 - 10:50	Pengzi Miao (University of Miami), *On interaction between scalar curvature and boundary mean curvature* (p. 191)
12:30 - 13:20	Jiawei Liu (Otto Von Guericke University of Magdeburg), *Ricci flow starting from an embedded closed convex surface in* $\mathbb{R}^3$ (p. 190)
15:00 - 15:20	Shubham Dwivedi (Humboldt University of Berlin), *Deformation theory of nearly* G_2 *manifolds* (p. 189)
15:30 - 15:50	Xi Sisi Shen (Northwestern University), *Estimates for metrics of constant Chern scalar curvature* (p. 192)
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Abstracts/Résumés

SPYROS ALEXAKIS, University of Toronto
[Monday June 7 / lundi 7 juin, 12:30]

HUSSEIN CHEIKH-ALI, Université Libre de Bruxelles
[Thursday June 10 / jeudi 10 juin, 16:30]
The second best constant for the Hardy-Sobolev inequality on manifolds

We consider the second best constant in the Hardy-Sobolev inequality on a Riemannian manifold. More precisely, we are interested with the existence of extremal functions for this inequality. This problem was tackled by Djadli-Druet [1] for Sobolev inequalities. Here, we establish the corresponding result for the singular case. In addition, we perform a blow-up analysis of solutions to Hardy-Sobolev equations of minimizing type. This yields informations on the value of the second best constant in the related Riemannian functional inequality.

Références

[1] Zindine Djadli and Olivier Druet, Extremal functions for optimal Sobolev inequalities on compact manifolds, Calc. Var. Partial Differential Equations **12** (2001), no. 1, 58–84.

EDWARD CHERNYSH, McGill University
[Thursday June 10 / jeudi 10 juin, 17:00]
A global compactness theorem for critical p-Laplace equations with weights

In this talk, we investigate the compactness of Palais-Smale sequences for a class of critical p-Laplace equations with weights. More precisely, we discuss a Struwe-type decomposition result for Palais-Smale sequences, thereby extending a recent result of Mercuri-Willem (2010) to weighted equations. In sharp contrast to the model case of the unweighted critical p-Laplace equation, all bubbling must occur at the origin. Furthermore, an adapted rescaling law is required to circumvent new difficulties introduced by the weights.

BEOMJUN CHOI, University of Toronto / KIAS
[Tuesday June 8 / mardi 8 juin, 13:30]
Liouville theorem for surfaces translating by sub-affine-critical powers of Gauss curvature

We construct and classify the translating solutions to the flows by sub-affine-critical powers of the Gauss curvature in $\mathbb{R}^3$. If α denotes the power, this corresponds to a Liouville theorem for degenerate Monge-Ampere equations $\det D^2 u = (1+|Du|^2)^{2-\frac{1}{2\alpha}}$ on $\mathbb{R}^2$ for $0 < \alpha < 1/4$. For the affine-critical case $\det D^2 u = 1$, a classical result by Jörgens, Calabi and Pogorelov shows the level curves of given solution are homothetic ellipses. In our case, the level curves converge asymptotically to a round circle or a curve with k-fold symmetry for some $3 \leq k \leq n_\alpha$. More precisely, these curves are closed shrinking curves to the $\frac{\alpha}{1-\alpha}$-curve shortening flow that were previously classified by Andrews in 2003. This is a joint work with K. Choi and S. Kim.

SHUBHAM DWIVEDI, Humboldt University, Berlin
[Friday June 11 / vendredi 11 juin, 15:00]
Deformation theory of nearly G_2 manifolds

We will discuss the deformation theory of nearly G_2 manifolds. These are seven dimensional manifolds admitting real Killing spinors. After briefly discussing the preliminaries, we will show that the infinitesimal deformations of nearly G_2 structures are obstructed in general. Explicitly, we will show that the infinitesimal deformations of the homogeneous nearly G_2 structure on the Aloff–Wallach space are all obstructed to second order. We will also completely describe the cohomology of nearly G_2 manifolds. This talk is based on a joint work with Ragini Singhal (University of Waterloo) (https://arxiv.org/abs/2007.02497).

PENGFEI GUAN, McGill University
[Wednesday June 9 / mercredi 9 juin, 10:00]
Locally constrained mean curvature type flows

The talk concerns a class of mean curvature type flows with constraints. The first of such flow involving mean curvature was considered in a previous joint work with Junfang Li to provide a flow approach to the classical isoperimetric inequality. Later, general fully nonlinear constrained flows were introduced for optimal geometric inequalities involving quermassintegrals. These flows are associated with variational properties of corresponding geometric quantities. We will discuss some recent results and open regularity problems.

ROBERT HASLHOFER, University of Toronto
[Tuesday June 8 / mardi 8 juin, 10:00]
Mean curvature flow through neck-singularities

In this talk, I will explain our recent work showing that mean curvature flow through neck-singularities is unique. The key is a classification result for ancient asymptotically cylindrical flows that describes all possible blowup limits near a neck-singularity. In particular, this confirms Ilmanen's mean-convex neighborhood conjecture, and more precisely gives a canonical neighborhood theorem for neck-singularities. Furthermore, assuming the multiplicity-one conjecture, we conclude that for embedded two-spheres mean curvature flow through singularities is well-posed. The two-dimensional case is joint work with Choi and Hershkovits, and the higher-dimensional case is joint with Choi, Hershkovits and White.

HAN HONG, University of British Columbia
[Monday June 7 / lundi 7 juin, 16:00]
Stability and index estiamtes of capillary surfaces

In this talk, we will discuss stability and index estimates for compact and noncompact capillary surfaces. A classical result in minimal surface theory says that a stable complete minimal surface in $\mathbb{R}^3$ must be a plane. We show that, under certain curvature assumptions, a strongly stable capillary surface in a 3-manifold with boundary has only three possible topological configurations. In particular, we prove that a strongly stable capillary surface in a half-space of $\mathbb{R}^3$ which is minimal or has the contact angle less than or equal to $\pi/2$ must be a half-plane. We also give index estimates for compact capillary surfaces in 3-manifolds by using harmonic one-forms. This is joint work with Aiex and Saturnino.

CHRISTOPHER KENNEDY, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:30]
A Bochner Formula on Path Space for the Ricci Flow

Aaron Naber (Northwestern) and Robert Haslhofer (Toronto) have characterized solutions of the Einstein equation $\mathrm{Rc}(g) = \lambda g$ in terms of both sharp gradient estimates for Brownian motion and a Bochner formula on elliptic path space PM. They also successfully characterized solutions of the Ricci flow $\partial_t g = -2\mathrm{Rc}(g)$ in terms of an infinite-dimensional gradient estimate on parabolic path space $P\mathcal{M}$ of space-time $\mathcal{M} = M \times [0,T]$.

In this talk, we shall generalize the classical Bochner formula for the heat flow on evolving manifolds $(M, g_t)_{t\in[0,T]}$ to an infinite-dimensional Bochner formula for martingales, thus proving the parabolic counterpart of recent results in the elliptic setting as well as characterizing solutions of the Ricci flow in terms of Bochner inequalities on parabolic path space. Time-permitting, we shall also discuss gradient and Hessian estimates for martingales on parabolic path space as well as a condensed proof of previous characterizations of the Ricci flow.

YANGYANG LI, Princeton University
[Tuesday June 8 / mardi 8 juin, 17:00]
Generic Regularity of Minimal Hypersurfaces in Dimension 8

The well-known Simons' cone suggests that minimal hypersurfaces could be possibly singular in a Riemannian manifold with dimension greater than 7, unlike the low dimensional case. Nevertheless, it was conjectured that one could perturb away these singularities generically. In this talk, I will discuss how to perturb them away to obtain a smooth minimal hypersurface in an 8-dimension closed manifold, by induction on the "capacity" of singular sets. This result generalizes the previous works by N. Smale and by Chodosh-Liokumovich-Spolaor to any 8-dimensional closed manifold. This talk is based on joint work with Zhihan Wang.

JIAWEI LIU, Otto-von-Guericke-University Magdeburg
[Friday June 11 / vendredi 11 juin, 12:30]
Ricci flow starting from an embedded closed convex surface in $\mathbb{R}^3$

We talk about the existence and uniqueness of Ricci flow that admits an embedded closed convex surface in $\mathbb{R}^3$ as metric initial condition. The main point is a family of smooth Ricci flows starting from smooth convex surfaces whose metrics converge uniformly to the metric of the initial surface in intrinsic sense. This is joint work with Jiuzhou Huang.

HUSSEIN MESMAR, lorraine university IECL
[Thursday June 10 / jeudi 10 juin, 16:00]
Solution for Hardy-Sobolev equation in presence of isometrie

Let $(M; g)$ be a smooth compact Riemannian manifold of dimension $n \geq 4$, G a closed subgroup of the group of isometries $Isom_g(M)$ of (M, g) and $k = \min_{x\in M} dimGx$, where Gx denotes the orbit of a point $x \in M$ under G. We fixe a point $x_0 \in M$ that $dimGx_0 = k$ and $s \in (0; 2)$. We say that a function $\phi : M \to \mathbb{R}$ is G-invariant if $\phi(gx) = \phi(x)$ for any $x \in M$ and $g \in G$. We investigate a suffcient condition for the existence of a distributional continuous positive G-invariant solution for the Hardy-Sobolev equation

$$\Delta_g u + au = \frac{u^{2^*(k,s)-1}}{d_g(x, Gx_0)^s} + hu^{q-1} \qquad \text{(E)}$$

where $\Delta_g := -div_g(\nabla)$ is the Laplace-Beltrami operator, ,a, $h \in C^0(M)$, $h \geq 0$, d_g is the Riemannian distance on $(M; g)$, $2^*(k, s) = \frac{2(n-k-s)}{n-k-2}$ and $q \in (2, 2^*(k, s))$ with $2^* = 2^*(0, 0)$. We prove that the existence of a Mountain Pass solution for the

above perturbative equation depends only on the perturbation. For that we need to prove first that for any $\epsilon > 0$, exist $A > 0$ and $B_\epsilon = B(\epsilon) \geq 0$ so that for any $u \in L^{2^*(k,s)}(M, d_g(x, Gx_0)^{-s})$

$$||u||^2_{L^{2^*(k,s)}(M,d_g(x,Gx_0)^{-s})} \leq (A+\epsilon)||\nabla u||_2^2 + B_\epsilon ||u||_2^2$$

PENGZI MIAO, University of Miami
[Friday June 11 / vendredi 11 juin, 10:00]
On interaction between scalar curvature and boundary mean curvature

Scalar curvature and mean curvature are some of the most basic curvature quantities associated to a Riemannian manifold and its hypersurfaces, respectively. In a relativistic context, scalar curvature relates to matter distribution in a spacetime and mean curvature is used to compute the quasi-local mass of a finite body. In Riemannian geometry, existence and non-existence of positive scalar curvature metrics is a fundamental question on closed manifolds. If the manifold is noncompact, important results on metrics with nonnegative scalar curvature include the Riemannian positive mass theorem and the Riemannian Penrose inequality. In this talk, we discuss how nonnegative scalar curvature in the interior of a compact manifold influences the mean curvature of its boundary hypersurface. Part of the talk is based on joint work with Siyuan Lu.

ALEX MRAMOR, Johns Hopkins University
[Tuesday June 8 / mardi 8 juin, 12:30]
On the unknottedness of self shrinkers

Self shrinkers are basic singularity models for the mean curvature flow. Much progress has been made in their study but outside some curvature convexity conditions and other special cases they are still not fully understood. In this talk I'll discuss some "unknottedness" results for self shrinkers in $\mathbb{R}^3$, which for instance imply that a self shrinking torus cannot be a tubular neighborhood of a nontrivial knot. The arguments discussed use the mean curvature flow and include some families of noncompact self shrinkers - closed self shrinkers were previously considered in a joint work with Shengwen Wang.

KEATON NAFF, Columbia University
[Tuesday June 8 / mardi 8 juin, 16:00]
A local noncollapsing estimate for mean curvature flow

We will discuss noncollapsing in mean curvature flow and prove a local version of the noncollapsing estimate. By combining our result with earlier work of X.-J. Wang, it follows that certain ancient convex solutions that sweep out the entire space are noncollapsed. This is joint work with S. Brendle.

JIEWON PARK, Caltech
[Wednesday June 9 / mercredi 9 juin, 16:00]
The Laplace equation on noncompact Ricci-flat manifolds

We will discuss geometric applications of the Laplace equation on a complete Ricci-flat manifold with Euclidean volume growth. We will focus on how to identify two arbitrarily far apart scales in the manifold in a natural way, exploiting the Łojasiewicz inequality of Colding-Minicozzi, in the case when a tangent cone at infinity has smooth cross section. We also prove a matrix Harnack inequality for the Green function when there is an additional condition on sectional curvature, which is an analogue of various matrix Harnack inequalities obtained by Hamilton and Li-Cao in different time-dependent settings.

SÉBASTIEN PICARD, UBC
[Wednesday June 9 / mercredi 9 juin, 13:30]
Topological Transitions of Calabi-Yau Threefolds

It was proposed in the works of Clemens, Reid and Friedman to connect Calabi-Yau threefolds with different topologies by a process known as a conifold transition. This operation may produce a non-Kahler complex manifold with trivial canonical bundle. In this talk, we will discuss the propagation of differential geometric structures such as metrics with special holonomy and Yang-Mills connections through conifold transitions. This is joint work with T. Collins and S.-T. Yau.

BRUNO PREMOSELLI, Université Libre de Bruxelles
[Thursday June 10 / jeudi 10 juin, 13:30]
Towers of bubbles for Yamabe-type equations in dimensions larger than 7

In this talk we consider perturbations of Yamabe-type equations on closed Riemannian manifolds. In dimensions larger than 7 and on locally conformally flat manifolds we construct blowing-up solutions that behave like towers of bubbles (or bubble-trees) concentrating at a critical point of the mass function. Our result does not assume any symmetry on the underlying manifold.

We perform our construction by combining finite-dimensional reduction methods with a linear blow-up analysis. Our approach works both in the positive and sign-changing case. As an application we prove the existence, on a generic bounded open set of $\mathbb{R}^n$, of blowing-up solutions of the Brézis-Nirenberg equation that behave like towers of bubbles with alternating signs.

FRÉDÉRIC ROBERT, Université de Lorraine
[Thursday June 10 / jeudi 10 juin, 10:00]
Blowing-up solutions for second-order critical elliptic equations: the impact of the scalar curvature

Given a closed manifold (M^n, g), $n \geq 3$, Olivier Druet proved that a necessary condition for the existence of energy-bounded blowing-up solutions to perturbations of the equation

$$\Delta_g u + h_0 u = u^{\frac{n+2}{n-2}},\ u > 0 \text{ in } M$$

is that $h_0 \in C^1(M)$ touches the Scalar curvature somewhere when $n \geq 4$ (the condition is different for $n = 6$). In this paper, we prove that Druet's condition is also sufficient provided we add its natural differentiable version. For $n \geq 6$, our arguments are local. For the low dimensions $n \in \{4, 5\}$, our proof requires the introduction of a suitable mass that is defined only where Druet's condition holds. This mass carries global information both on h_0 and (M, g).

XI SISI SHEN, Northwestern University
[Friday June 11 / vendredi 11 juin, 15:30]
Estimates for metrics of constant Chern scalar curvature

We discuss the existence problem of constant Chern scalar curvature metrics on a compact complex manifold. We prove a priori estimates for these metrics conditional on an upper bound on the entropy, extending a recent result by Chen-Cheng in the Kähler setting.

VLADMIR SICCA, McGill University
[Wednesday June 9 / mercredi 9 juin, 16:30]
A prescribed scalar and boundary mean curvature problem on compact manifolds with boundary

In this talk I will present our recent result in the problem of finding a metric in a given conformal class with prescribed nonpositive scalar curvature and nonpositive boundary mean curvature, on a compact manifold with boundary. We established

a necessary and sufficient condition in terms of a conformal invariant that measures the zero set of the target curvatures, which we call the relative Yamabe invariant of the set. (This is a joint work with Gantumur Tsogtgerel).

FREID TONG, Columbia University
[Friday June 11 / vendredi 11 juin, 16:00]
On the degenerations of asymptotically conical Calabi-Yau metrics

The analytic study of complete non-compact Ricci-flat Kahler metrics began with the work of Tian-Yau in the 90s, who used PDE methods to produce many interesting examples of such metrics. In this talk, we will discuss the degenerations of non-compact Ricci-flat Kahler metrics from an analytic point of view: by studying the limit of the corresponding complex Monge-Ampere equations. In certain cases, we will see that the degenerate metric limit induces a complete singular Ricci-flat Kahler metric on a quasi-projective variety and we will discuss the applications to constructions of complete Ricci-flat Kahler metrics with singularities. This is joint work with T. Collins and B. Guo.

JUNCHENG WEI, University of British Columbia
[Thursday June 10 / jeudi 10 juin, 12:30]
Sharp quantitative estimates for Struwe's decomposition

Suppose $u \in D^{1,2}(\mathbb{R}^n)$. In a fundamental paper in 1984, Struwe proved that if $||\Delta u + u^{\frac{2n}{n-2}}||_{H^{-1}} := \Gamma(u) \to 0$ then $\delta(u) \to 0$, where $\delta(u)$ denotes the $D^{1,2}(\mathbb{R}^n)$-distance of u from the manifold of sums of Talenti bubbles, i.e.

$$\delta(u) := \inf_{\substack{(z_1,\cdots,z_\nu)\in\mathbb{R}^n \\ \lambda_1,\cdots,\lambda_\nu>0}} \left\| \nabla u - \nabla \left(\sum_{i=1}^{\nu} U\left[z_i, \lambda_i\right] \right) \right\|_{L^2}.$$

In 2019, Figalli and Glaudo obtained the first quantitative version of Struwe's decomposition in lower dimensions, namely $\delta(u) \lesssim \Gamma(u)$ when $3 \leq n \leq 5$. In this talk, I will present the following quantitative estimates of Struwe's decomposition in higher dimensions:

$$\delta(u) \leq C \begin{cases} \Gamma(u)\,|\log \Gamma(u)|^{\frac{1}{2}} & \text{if } n = 6, \\ |\Gamma(u)|^{\frac{n+2}{2(n-2)}} & \text{if } n \geq 7. \end{cases}$$

Furthermore, we show that this inequality is sharp. (Joint work with B. Deng and L. Sun.)

FENGRUI YANG, McGill University
[Monday June 7 / lundi 7 juin, 17:00]
Prescribed curvature measure problem in hyperbolic space

The problem of the prescribed curvature measure is one of the important problems in differential geometry and nonlinear partial differential equations. In this talk, I will talk about prescribed curvature measure problem in hyperbolic space. We establish the existence and regularity of solutions to the problem. The key is the C^2 regularity estimates for solutions to the corresponding fully nonlinear PDE in the hyperbolic space.

SIYI ZHANG, University of Notre Dame
[Monday June 7 / lundi 7 juin, 16:30]
Conformally invariant rigidity theorems on four-manifolds with boundary

We introduce conformal and smooth invariants on oriented, compact four-manifolds with boundary and show that "positivity" conditions on these invariants will impose topological restrictions on underlying manifolds with boundary. We also establish

conformally invariant rigidity theorems for Bach-flat four-manifolds with boundary under the assumptions on these invariants. It is noteworthy to point out that we rule out some examples arising from the study of closed manifolds in the setting of manifolds with umbilic boundary.

XIANGWEN ZHANG, UC Irvine
[Wednesday June 9 / mercredi 9 juin, 12:30]
A geometric flow for Type IIA superstrings

The equations of flux compactifications of Type IIA superstrings were written down by Tomasiello and Tseng-Yau. To study these equations, we introduce a natural geometric flow on symplectic Calabi-Yau 6-manifolds. We prove the well-posedness of this flow and establish the Shi-type estimates which provides a criterion for the long time existence. As an application, we make use of our flow to find optimal almost complex structures on certain homogeneous symplectic half-flat manifolds. This is based on joint work with Fei, Phong and Picard.

Online teaching from now on
Enseignement en ligne . . . A partir de maintenant

Org: Benoit Dionne (Ottawa)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Brian Forrest (University of Waterloo), *Teaching Mathematics Online: Then, Now and Going Forward.* (p. 195)
13:00 - 13:30	Zohreh Shahbazi (University of Toronto, Scarborough), *Assessment Design in Online Math Courses* (p. 196)
13:30 - 14:00	Sean Fitzpatrick (University of Lethbridge), *The online shift: teaching with empathy* (p. 195)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Peter Taylor (Queen's University), *Teaching in the Global Village* (p. 196)
13:00 - 13:30	Miroslav Lovric (McMaster University), *If online then A else B* (p. 196)
13:30 - 14:00	Andie Burazin (University of Toronto Mississauga), *Mind the gap* (p. 195)
14:00 - 14:30	Veselin Jungic (Simon Fraser University), *COVIDization of my classroom* (p. 196)

Abstracts/Résumés

ANDIE BURAZIN, University of Toronto Mississauga
[Tuesday June 8 / mardi 8 juin, 13:30]
Mind the gap

In pre-Covid times, we made assumptions about our students' background knowledge. Sometimes as the expert we forget how it is for the novice to experience and understand math and its language. But has the online teaching and learning environment, during this Covid disruption and potentially even when we get back to some in-person normality, made the gap between instructors and students larger from course expectations to curriculum to assessments ?

SEAN FITZPATRICK, University of Lethbridge
[Monday June 7 / lundi 7 juin, 13:30]
The online shift: teaching with empathy

As mathematicians, we are enamoured with out subject, and enter the classroom believing that our students, once exposed to the beauty of mathematics, will be too. Of course, things do not usually turn out as planned. What matters, perhaps, is not what we write on the board, but how students feel while they're in our class.

A colleague in our university's Teaching Centre made the following observation during a meeting: there are two types of university teacher – those who care most about their subject, and those who care most about their students. During our pandemic-induced shift online, I would argue that of the two, the latter was more successful.

In a campus-wide student perception survey that asked students how their instructors best supported their learning this year, there was one recurring theme: empathy. Students got the most out of the courses where they felt their instructors understood the challenges they were facing, and were willing to provide flexibility and support. I'll discuss some lessons learned, and how they will impact my teaching going forward, whether in person or online.

BRIAN FORREST, University of Waterloo
[Monday June 7 / lundi 7 juin, 12:30]
Teaching Mathematics Online: Then, Now and Going Forward.

In this talk I will look back at nearly 20 years of developing and teaching online mathematics courses. I will start with a brief over view of where we came from and then focus on how things have changed, particularly over the last year. I will end the talk with some thoughts on where we might go from here.

VESELIN JUNGIC, Department of Mathematics, Simon Fraser University
[Tuesday June 8 / mardi 8 juin, 14:00]
COVIDization of my classroom

My experience teaching online over the last year was mixed and included very low points and some victories too. I will use a few examples to illustrate this period in an attempt to explain the significance of this wide range of experiences.

I will also describe an unexpected encounter in a park on a sunny afternoon that made me realize that 2020/2021 was a lost year in my career of over 40 years as a teacher.

MIROSLAV LOVRIC, McMaster University
[Tuesday June 8 / mardi 8 juin, 13:00]
If online then A else B

I will present blueprints for the scientific programming course (in Python) that I will teach in Winter 2022, either face to face or online. Having taught a similar course in pre-Covid times, and then in Winter 2021, I have a variety of experiences and ideas which I hope will make my course richer, attractive and beneficial to my students.

ZOHREH SHAHBAZI, University Of Toronto Scarborough
[Monday June 7 / lundi 7 juin, 13:00]
Assessment Design in Online Math Courses

In this session, we will be exploring traditional and modern practices, as well as my personal thoughts and ideas for employing assessment tools that enhance learning mathematics topics in online environments. Designing online assessment methods that are well integrated with teaching activities and learning goals has a significant role in reducing students' anxiety and academic misconduct cases.

PETER TAYLOR, Queen's
[Tuesday June 8 / mardi 8 juin, 12:30]
Teaching in the Global Village

Covid-19 has given us an ultimate experience of the global village: virus particles, viral videos and my calculus solutions now travel effortlessly around the globe. This has been happening for a while but the past year of online learning has transformed expectations. Students now ask: "if it's okay to learn from Khan Academy, why is it not okay to grab hold of this elegant calculation that my friend told me to check out?" It's hard to construct good problems; I am thinking that I will no longer distribute my good solutions.

Operations Research
Recherche opérationnelle

Org: Bao Nguyen and/et **Davide Spinello** (Ottawa)

Schedule/Horaire

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Prof. Joanna Olszewska (University of the West of Scotland), *Algorithms for Intelligent Vision Systems* (p. 197)
13:00 - 13:30	Dr. Peter Dobias (Defence R&D Canada), *Non-equilibrium systems, fractals, and phase transitions* (p. 197)
13:30 - 14:00	Prof. Liam Paull (University of Montreal), *Training Robots in Simulators* (p. 198)
14:00 - 14:30	Dr. Greg Van Bavel (Defence R&D Canada), *Prioritization and Pareto Efficient Sets: Non-dominated Sorting for Multiple-Criteria Decision Analysis* (p. 198)
16:00 - 16:30	Prof. Bao Uyen (uOttawa/Defence R&D Canada), *Stopping condition processes for multiple entities* (p. 198)

Abstracts/Résumés

DR. PETER DOBIAS, Defence Research and Development Canada
[Thursday June 10 / jeudi 10 juin, 13:00]
Non-equilibrium systems, fractals, and phase transitions

Despite the fact that simple equilibrium distributions, including Gaussian or exponential distributions, are commonly used to model many natural and socio-economic systems, it could be argued that many systems in nature as well as in society are in fact far from equilibrium and that the use of these distributions is not appropriate and can lead to underestimating risk of extreme events. In fact, observations suggest that many systems exhibit critical properties such as power law scaling of their size-frequency distribution, and complicated distributions. In this paper we describe the general characteristics of such systems, and then we present two examples, one from natural, and one from social systems. The first example looks at the earth's magnetosphere. The magnetospheric characteristics commonly exhibit scaling properties, internal correlations, and noise common to phase transitions. This fact indicates that despite the fact that the common analyses focus on specific triggers, it is the overall state of the system that really matters. This is consistent with a body of theoretical and experimental research in space physics. In the socio-economic domain a prominent example heavily studied over the last decade relates to asymmetric warfare and terrorism. Again, both of these types of violence exhibit scaling properties common to critical systems. If they are indeed behaving as non-equilibrium, critical, systems, this would have implications for both the trend interpretation and for predictive analysis. We will discuss a body of work comparing modelling and observations that support this notion.

PROF. JOANNA OLSZEWSKA, UWS, UK
[Thursday June 10 / jeudi 10 juin, 12:30]
Algorithms for Intelligent Vision Systems

Intelligent vision systems (IVS) are a set of interconnected hardware and/or software components which take digital image(s) as input data and process them by means of methods ranging from low- to high-level techniques/algorithms in order to extract meaningful information, which could be structured and organized into knowledge, and aid to the automatic understanding of the gathered visual data. Nowadays, IVS are present in a wide range of applications, ranging from autonomous vehicles to assisted-living devices ; from rescue operations to video surveillance. These systems aim to get a higher autonomy as well as further levels of automated reasoning based on visual input and involves softwares integrating AI-based algorithms. Hence, the design of the new generation IVS is facing several challenges such as correctness and learnability as well as security and

transparency. In particular, the choice of adequate algorithms for IVS is of prime importance. Indeed, these algorithms must be not only reliable and accurate, but also explainable and portable. Hence, this talk focuses on presenting efficient algorithms for the IVS dedicated to tasks such as the automated detection, recognition, and tracking of objects of interest.

PROF. LIAM PAULL, Université de Montréal
[Thursday June 10 / jeudi 10 juin, 13:30]
Training Robots in Simulators

One paradigm to building robotic agents is reinforcement learning. It is flexible and general. However, there are some particular challenges with respect to training RL agents on real physically embodied systems. For example: RL training tends to be quite innefficient and performing rollouts on a real robot system is expensive, real world environments don't automatically reset, and real world environments don't necessarily provide a reward signal to the agent explicitly. To overcome these challenges, training agents in simulators is appealing. However, the new problem becomes ensuring that an agent trained in a simulator generalizes to the real environment, the so-called sim2real problem. In this talk we will present two paradigms for tackling the sim2real, which we refer to as "Learn to Transfer" and "Learn to Generalize". We will also outline some future directions that we are pursuing in the Montreal Robotics and Embodied AI Lab (REAL) in this direction. Finally, I will also briefly describe our AI Driving Olympics project in connection to the problem of robotics benchmarking and "sim2real" transfer.

PROF. BAO UYEN, uOttawa/Defence R&D Canada
[Thursday June 10 / jeudi 10 juin, 16:00]
Stopping condition processes for multiple entities

In both natural and artificial systems there are many stochastic processes which require a stopping condition. Examples of such processes include flipping a coin until we get a head, drawing a card until a certain value is obtained, or imposing a lockdown until the number of infections is below desired threshold. In this talk, we present the derivation of a general stopping condition for multiple entities (e.g., multiple coins) each with a number of opportunities and a total number of trials. Then we provide some real life examples how these conditions work, such as the Shoot-Look-Shoot tactics in air defence engagements or the community lockdown policies currently used all over the world.

DR. GREG VAN BAVEL, Government of Canada
[Thursday June 10 / jeudi 10 juin, 14:00]
Prioritization and Pareto Efficient Sets: Non-dominated Sorting for Multiple-Criteria Decision Analysis

The prioritization of options occurs frequently at the Department of National Defence. In many cases, the prioritization effort is a response to a situation in which there are many options, but only enough resources to satisfy the requirements of a fraction of the options. The use of multiple criteria and a team of subject matter experts to evaluate the options against those criteria is a conventional way to prioritize many options. This report discusses a well-established method, called non-dominated sorting, that systematically processes multiple evaluations of multiple criteria and thereby organizes the many options into prioritized sets, which are eminently suitable for trade-of discussions and negotiations. By using simple examples and detailed demonstrations, this presentation takes a closer look at an old method. The development of visualizations aid the presentation of results from two actual cases. The real-world cases yield empirical evidence related to the practical utility of non-dominated sorting and entail recommendations regarding how decision analysts can make the most of the method in their own work.

Operator algebras and applications
Algèbres d'opérateurs et applications

Org: Thierry Giordano (Ottawa), **Ian Putnam** (Victoria) and/et **Aaron Tikuisis** (Ottawa)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
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13:00 - 13:30	Judith Packer (University of Colorado at Boulder), *Cocycles on groupoids associated to $\mathbb{N}^k$-actions, and dynamics on the associated C^*-algebra* (p. 202)
13:30 - 14:00	Dilian Yang (University of Windsor), *Higman-Thompson Like Groups of k-Graph C*-Algebras* (p. 204)
16:00 - 16:30	George Elliott (University of Toronto), *A garden of simple C*-algebras* (p. 201)
16:30 - 17:00	Maria Grazia Viola (Lakehead University), *Structural properties and classification of Cuntz-Pimsner algebras associated to C*-correspondences over commutative C*-algebras* (p. 204)
17:00 - 17:30	Andrew Dean (Lakehead University), *Classification of nonsimple real AI algebras* (p. 201)

Tuesday June 8	**mardi 8 juin**
10:00 - 10:30	Charles Starling (Carleton University), *Partial isometric representations of semigroups* (p. 203)
10:30 - 11:00	Jason Crann (Carleton), *Amenable dynamical systems through Herz-Schur multipliers* (p. 200)
12:30 - 13:00	Martin Argerami (University of Regina), *Affine Operator Systems* (p. 200)
13:00 - 13:30	Ken Davidson (University of Waterloo), *Strongly Peaking Representations and Compressions of Operator Systems* (p. 200)
13:30 - 14:00	Raphaël Clouâtre (University of Manitoba), *Finite dimensionality in the non-commutative Choquet boundary* (p. 200)
14:00 - 14:30	Boyu Li (University of Victoria), *Dilation theory for right LCM semigroup dynamical systems* (p. 202)
16:00 - 16:30	Chris Ramsey (MacEwan University), *The isomorphism problem for tensor algebras of multivariable dynamical systems* (p. 203)
16:30 - 17:00	Sarah Plosker (University of Regina/Brandon University), *Complete order equivalence of spin operator systems* (p. 202)
17:00 - 17:30	Nico Spronk (University of Waterloo), *On operator amenability of Fourier-Stieltjes algebras* (p. 203)

Wednesday June 9	**mercredi 9 juin**
12:30 - 13:00	Karen Strung (Czech Academy of Sciences) (p. 204)
13:00 - 13:30	Masoud Khalkhali (University of Western Ontario), *Phase transition in some Dirac Ensembles* (p. 201)
13:30 - 14:00	Marcelo Laca (University of Victoria), *Universal Toeplitz algebras and their boundary quotients* (p. 202)
14:00 - 14:30	Heath Emerson (University of Victoria), *Zeta functions of Heisenberg cycles and dynamics* (p. 201)
16:00 - 16:30	James Mingo (Queen's University), *Free compression and Standard Young Tableau* (p. 202)
16:30 - 17:00	Paul Skoufranis (York University), *Bi-Free Entropy with Respect to a Completely Positive Map* (p. 203)

Thursday June 10	**jeudi 10 juin**
16:00 - 16:30	Matthew Wiersma (University of California), *Cohomological obstructions to lifting properties for full group C*- algebras* (p. 204)
16:30 - 17:00	Ionut Chifan (University of Iowa), *New examples of W* and C*-superrigid groups* (p. 200)
17:00 - 17:30	Matthew Kennedy (University of Waterloo), *Amenability, proximality and higher order syndeticity* (p. 201)

Abstracts/Résumés

MARTIN ARGERAMI, University of Regina
[Tuesday June 8 / mardi 8 juin, 12:30]
Affine Operator Systems

We consider operator systems generated by commuting tuples of normal operators. We obtain a complete classification of such operator systems, thus solving several cases where the situation was poorly understood. We also explore the relation with Arveson's essential normality conjecture.

IONUT CHIFAN, University of Iowa
[Thursday June 10 / jeudi 10 juin, 16:30]
New examples of W and C*-superrigid groups*

In the thirties F. J. Murray and J. von Neumann found a natural way to associate a von Neumann algebra L(G) to every countable discrete group G. Classifying L(G) in terms of G emerged overtime as a natural yet quite challenging problem as these algebras tend to have very limited "memory" of the underlying group. This is perhaps best illustrated by Connes' famous result asserting that all icc amenable groups give rise to isomorphic von Neumann algebras; thus in this case, besides amenability, the algebra has no recollection of the structure of underlying group. However, in the non-amenable regime the situation is far more complex; examples where the von Neumann algebraic structure is sensitive to various algebraic group properties have been discovered via Popa's deformation/rigidity theory. In this talk I will present new instances of groups G that are completely recognizable from L(G). Our classes of examples include amalgamated free products, HNN extensions, and co-induced groups. In addition, I will discuss several applications to the study of rigidity in the C*-setting. This is based on recent joint works with A. Diaz-Arias and D. Drimbe.

RAPHAËL CLOUÂTRE, University of Manitoba
[Tuesday June 8 / mardi 8 juin, 13:30]
Finite dimensionality in the non-commutative Choquet boundary

The non-commutative Choquet boundary of an operator algebra consists of $*$-representations with a certain unique extension property. In this talk, I will investigate the question of existence of finite-dimensional boundary points, which is a non-trivial issue even for finite-dimensional operator algebras. I will explain how this question is related to the residual finite-dimensionality of the C^*-envelope, and how finite-dimensional boundary points can be detected by tools from non-commutative function theory. Furthermore, I will explore the extremal case of C^*-liminal operator algebras – where all boundary points are finite-dimensional – via some recent developments in matrix convexity. This is joint work with Ian Thompson.

JASON CRANN, Carleton University
[Tuesday June 8 / mardi 8 juin, 10:30]
Amenable dynamical systems through Herz-Schur multipliers

A generalized theory of Herz-Schur multipliers for dynamical systems has recently emerged through independent work of Bédos-Conti and McKee-Todorov-Turowska. In this talk, we generalize the well-known Herz-Schur multiplier characterizations of amenability to W*- and C*-dynamical systems over arbitrary locally compact groups. As byproducts of our results, we (1) answer a question of Anantharaman-Delaroche and obtain a Reiter type characterization of amenable W*-dynamical systems, and (2) show that a commutative C*-dynamical system is amenable if and only if the underlying action is topologically amenable. Combined with recent work of Buss-Echterhoff-Willett, this latter result implies the equivalence between topological amenability and measurewise amenabilty for G-spaces X when both G and X are second countable. This is joint work with Alex Bearden.

KEN DAVIDSON, U. Waterloo
[Tuesday June 8 / mardi 8 juin, 13:00]
Strongly Peaking Representations and Compressions of Operator Systems

An operator system is *fully compressed* if the compression to any proper subspace fails to be completely isometric. We completely characterize fully compressed separable operator systems in terms of strongly peaking representations, and also in terms of the representation theory of its C*-envelope. The fully compressed representation is unique up to unitary equivalence. The notion of matrix convexity underlies the main ideas.

This is joint work with Ben Passer.

ANDREW DEAN, Lakehead University
[Monday June 7 / lundi 7 juin, 17:00]
Classification of nonsimple real AI algebras

We shall discuss the classification of not necessarily simple real C*-algebras that arise as inductive limits of real forms of finite direct sums of matrix algebras over the continuous functions on the unit interval using Cuntz semigroups.

This is joint work with Luis Santiago.

GEORGE ELLIOTT, University of Toronto
[Monday June 7 / lundi 7 juin, 16:00]
A garden of simple C-algebras*

A (very) brief status report is given on the classification of C*-algebras, and of group actions on them.

HEATH EMERSON, University of Victoria
[Wednesday June 9 / mercredi 9 juin, 14:00]
Zeta functions of Heisenberg cycles and dynamics

Along the orbit of a smooth ergodic flow on a compact manifold$M$, placing a Dirac-Schrodinger operator $x + \frac{d}{dx}$ determines a spectral triple over $C(M) \rtimes \mathbf{R}_d$, the crossed product of $C(M)$ by the group of real numbers with the discrete topology, acting on M by the flow. Such Heisenberg cycles generate analytic zeta functions $\zeta(f) = \mathrm{trace}(fH^{-s})$, with $H = -\frac{d^2}{dx^2} + x^2$ the harmonic oscillator, and as we show, the meromorphic and pole structure of these zeta functions seems to detect fine information about ergodic averages in dynamics. We demonstrate this for the periodic flow on the circle, and the Krönecker flow on $\mathbf{T}^2$, and briefly summarize various applications to K-theory.

MATTHEW KENNEDY, University of Waterloo
[Thursday June 10 / jeudi 10 juin, 17:00]
Amenability, proximality and higher order syndeticity

I will discuss new descriptions of some universal flows associated to a discrete group, obtained using what we view as a kind of "topological Furstenberg correspondence." The descriptions are algebraic and relatively concrete, involving subsets of the group satisfying a higher order notion of syndeticity. We utilize them to establish new necessary and sufficient conditions for strong amenability and amenability. Throughout, I will discuss connections to operator algebras. This is joint work with Sven Raum and Guy Salomon.

MASOUD KHALKHALI, Western Ontario
[Wednesday June 9 / mercredi 9 juin, 13:00]
Phase transition in some Dirac Ensembles

After a quick introduction to some of the ideas of random matrix theory, I shall focus on current efforts to prove the existence of phase transition in some random matrix models suggested by noncommutative geometry. The talk is based on my recent joint papers arXiv:2006.02891: Phase transitions in random noncommutative geometries ; and arXiv:1906.09362: Random finite noncommutative geometries and topological recursion.

MARCELO LACA, University of Victoria
[Wednesday June 9 / mercredi 9 juin, 13:30]
Universal Toeplitz algebras and their boundary quotients

I will present a universal model for the Toeplitz algebra of a submonoid of a group, define its universal boundary quotient, and characterize their faithful representations and their uniqueness and simplicity properties. To give a context for our results I will start by reviewing classical work of Coburn, Douglas, and Cuntz on C*-algebras generated by isometries and also generalizations due to Nica, Li, and Raeburn and myself. This is recent joint work with Camila F. Sehnem.

BOYU LI, University of Victoria
[Tuesday June 8 / mardi 8 juin, 14:00]
Dilation theory for right LCM semigroup dynamical systems

We consider the dilation theory for a certain type of semigroup dynamical systems that encode the right LCM structure of the semigroup. This leads to a generalized Naimark dilation theorem and Stinespring's dilation theorem for these semigroup dynamical systems. As an application, we prove a dilation result for contractive representations of the boundary quotient. This is a joint work with Marcelo Laca.

JAMES MINGO, Queen's University
[Wednesday June 9 / mercredi 9 juin, 16:00]
Free compression and Standard Young Tableau

In 1959 H. Kesten found a probability measure whose moments count the number of closed walks on a free group with d generators, now known as the Kesten-McKay law. For non-integer $d \geq 1$ there is still a probability measure but no group, however the $2n^{th}$ moment is still a polynomial of degree n with coefficients in the positive integers ; the odd moments being 0. Nica and Speicher showed that the free compression of a Bernoulli random variable has the same law. In this talk we shall show that these moments can also be interpreted in terms of standard Young tableau with specified shape. This is joint work with Iris Arenas Longoria.

JUDITH PACKER, University of Colorado, Boulder
[Monday June 7 / lundi 7 juin, 13:00]
Cocycles on groupoids associated to $\mathbb{N}^k$-actions, and dynamics on the associated C^*-algebra

We construct a locally compact Hausdorff etale groupoid $\mathcal{G}$ from k commuting surjective local homeomorphisms acting on a compact metric space X. We characterize the continuous 1-cocycles in the groupoid $\mathcal{G}$ taking on values in $\mathbb{R}$, in terms of k-tuples of continuous real-valued functions on the unit space of $\mathcal{G}$ satisfying certain canonical identities. Under appropriate conditions, we construct a one-parameter automorphism group acting on the groupoid C^*-algebra $C^*(\mathcal{G})$ corresponding to the continuous 1-cocycle on $\mathcal{G}$. The question of the existence of KMS states on $C^*(\mathcal{G})$ associated to these one-parameter automorphism groups is addressed. The work discussed is joint with C. Farsi, L. Huang, and A. Kumjian.

SARAH PLOSKER, Brandon University
[Tuesday June 8 / mardi 8 juin, 16:30]
Complete order equivalence of spin operator systems

Spin systems are finite sets of anticommuting selfadjoint unitary matrices. We focus on complete order isomorphisms between the operator systems generated by these sets: linear isomorphisms such that the matricial order within these spaces is preserved. We extend our work to the case of countable many unitaries. We also consider the C*-envelope associated to such operator systems.

CHRIS RAMSEY, MacEwan University
[Tuesday June 8 / mardi 8 juin, 16:00]
The isomorphism problem for tensor algebras of multivariable dynamical systems

We show that unitary equivalence after a conjugation for multivariable dynamical systems is a complete invariant for complete isometric isomorphisms between their tensor algebras. The result is achieved by way of Mobius transformations in this context. This is joint work with Elias Katsoulis (ECU).

SARAH REZNIKOFF, Kansas State University
[Monday June 7 / lundi 7 juin, 12:30]
A picture of Cartan subalgebras in twisted k-graph algebras

In 2008, Renault proved that every topologically principal groupoid C*-algebra contains a Cartan subalgebra. We recall work with Duwenig and Gillaspy that shows certain non-topologically principal twisted groupoid C*-algebras contain Cartan subalgebras, and in the case that the groupoid is the path groupoid of a k-graph we describe certain subgroupoids that give rise to these subalgebras. This is joint work with Anna Duwenig, Elizabeth Gillaspy, Rachael Norton, and Sarah Wright.

PAUL SKOUFRANIS, York University
[Wednesday June 9 / mercredi 9 juin, 16:30]
Bi-Free Entropy with Respect to a Completely Positive Map

Free entropy, as developed by Voiculescu in the 1990s, is an essential concept in free probability and is used to prove numerous results in operator algebras. The non-microstate version of free entropy, which is based on a conjugate variable system and a notion of free Fisher information, was generalized by Shlyakhtenko to incorporate a completely positive map. In this talk, we will examine this notion of free entropy with respect to a completely positive map, its applications, and its extension to the bi-free setting.

NICO SPRONK, Uinversity of Waterloo
[Tuesday June 8 / mardi 8 juin, 17:00]
On operator amenability of Fourier-Stieltjes algebras

Fourier-Stietjes algebras of locally compact groups are dual objects to measure algebras in a manner generalizing Pontryagin duality. For certain considerations around this duality, it is natural to expect that for a Fourier-Stietjes algebra to be operator amenable, it is necessary that the underlying group be compact. This is not true, a shown by Runde and me some years ago, but is true for almost connected groups. I will discuss my method for showing this, which uses some weakly almost periodic topological dynamics.

CHARLES STARLING, Carleton University
[Tuesday June 8 / mardi 8 juin, 10:00]
Partial isometric representations of semigroups

In his thesis, Tolich described a class of C*-algebras associated to doubly quasi-lattice ordered groups—these are groups G which have a left- and right-invariant order determined by a subsemigroup P. This generalized work of Raeburn and Hancock on the universal C*-algebra generated by a single power partial isometry (i.e. the case where $G = \mathbb{Z}$ and $P = \mathbb{N}$). We generalize this construction further to the case of LCM semigroups P, construct a suitable boundary quotient, and make the case that these algebras are an appropriate two-sided companion to Cuntz-Li algebras associated to such semigroups.

This is joint work with Ilija Tolich.

KAREN STRUNG, Czech Academy of Sciences
[Wednesday June 9 / mercredi 9 juin, 12:30]

MARIA GRAZIA VIOLA, Lakehead University
[Monday June 7 / lundi 7 juin, 16:30]
Structural properties and classification of Cuntz-Pimsner algebras associated to C-correspondences over commutative C*-algebras*

Cuntz-Pimsner algebras were introduced by Pimsner in the '90s, as generalization of both Cuntz-Krieger algebras and crossed products by the integers. In this talk we discuss several regularities properties of Cuntz-Pimsner algebras arising from full, minimal, non-periodic, and finitely generated projective C*-correspondence over commutative C*-algebras. A large class of examples is obtained considering the set $\Gamma(V, \alpha)$ of continuous sections of a complex vector bundle on a compact metric space X, where left multiplication is given by a twist by a minimal homeomorphism $\alpha\colon X \to X$.

In the case of crossed products by minimal homeomorphisms, the orbit breaking subagebra, defined by I. Putnam, is a large subalgebra in the sense of N. C. Phillips. We show that for a large class of C*-correspondences, the Cuntz-Pismner algebra $\mathcal{O}(\Gamma(V, \alpha))$ also contains a large subalgebras. We will discuss some properties that $\mathcal{O}(\Gamma(V, \alpha))$ and/or its large subalgebra have, focusing on properties needed for classification by the Elliott invariant, like nuclear dimension, $\mathcal{Z}$-stability, etc.

This is joint work with M. S. Adamo, D. Archey, M. Forough, M. Georgescu, J. A Jeong, and K. Strung.

MATTHEW WIERSMA, University of California, San Diego
[Thursday June 10 / jeudi 10 juin, 16:00]
Cohomological obstructions to lifting properties for full group C- algebras*

We develop a new method, based on non-vanishing of second cohomology groups, for proving the failure of lifting properties for full C*-algebras of countable groups with (relative) property (T). We derive that the full C*-algebras of the groups $\mathbb{Z}^2 \rtimes \mathrm{SL}_2(\mathbb{Z})$ and $\mathrm{SL}_n(\mathbb{Z})$, for $n \geq 3$, do not have the local lifting property (LLP). We also prove that the full C*-algebras of a large class of groups with property (T) do not have the lifting property (LP). This is based on joint work with A. Ioana and P. Spaas.

DILIAN YANG, University of Windsor
[Monday June 7 / lundi 7 juin, 13:30]
Higman-Thompson Like Groups of k-Graph C-Algebras*

Let Λ be a row-finite and source-free k-graph with finitely many vertices. In this talk, we present a notion of the Higman-Thompson like group Λ_{ht} associated to the graph C*-algebra $\mathcal{O}_\Lambda$. We show that Λ_{ht} is closely related to the topological full groups of the groupoid associated with Λ. Some properties of Λ_{ht} are also discussed.

Optimal transport and applications
Transport optimale et applications

Org: Young-Heon Kim (UBC) and/et **Brendan Pass** (Alberta)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Hugo Lavenant (UBC), *The Branching Schrödinger Problem* (p. 206)
13:00 - 13:30	Kelvin Shuangjian Zhang (ENS-Paris), *Strong duality of the principal-agent problem with bilinear preferences and its application to characterize the solutions* (p. 208)
13:30 - 14:00	Geoff Schiebinger (UBC), *Towards a Mathematical Theory of Development* (p. 207)
16:00 - 16:30	Samer Dweik (UBC) (p. 205)
16:30 - 17:00	Levon Nurbekyan (McGill), *Parameter identification for chaotic dynamical systems via optimal transport* (p. 207)
17:00 - 17:30	Dave Schneider (Saskatchewan), *Kac goes to work: Stochastic processes as probes of the architecture of plant root systems* (p. 207)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Maxime Jacky P. Laborde (McGill), *An augmented Lagrangian method for transportation distance with bulk/interface interactions* (p. 206)
13:00 - 13:30	Adolfo Vargas-Jimenez (Alberta), *Monge solutions and uniqueness in multi-marginal optimal transport via graph theory* (p. 208)
13:30 - 14:00	Nam Le (Indiana University), *Approximating minimizers of the Rochet-Chone functional with non-quadratic costs by solutions of singular Abreu equations* (p. 206)
14:00 - 14:30	Abbas Momeni (Carleton), *Supports of extremal doubly stochastic measures and the uniqueness of the Kantorovitch optimizer* (p. 207)
16:00 - 16:30	Christian Ketterer (Toronto), *Glued spaces and lower curvature bounds* (p. 206)
16:30 - 17:00	Ting-Kam Leonard Wong (Toronto), *Pseudo-Riemannian geometry embeds information geometry in optimal transport* (p. 208)
17:00 - 17:30	Almut Burchard (Toronto), *How to differentiate functionals involving higher order derivatives along geodesics* (p. 205)
17:30 - 18:00	Robert McCann (Toronto), *Maximizing the sum of angles between pairs of lines in Euclidean space* (p. 206)

Abstracts/Résumés

ALMUT BURCHARD, University of Toronto
[Tuesday June 8 / mardi 8 juin, 17:00]
How to differentiate functionals involving higher order derivatives along geodesics

I will describe work with Benjamin Schachter on differentiating functionals along Wasserstein geodesics, using an Eulerian point of view. The cost functions c(x,y) we consider are defined by minimizing the integral of a suitable Lagrangian among paths from x to y. We develop a formal procedure for computing derivatives of arbitrary order, and then appeal to the theory of transport equations (first-order linear PDE) to prove that the functionals vary smoothly along the geodesics, even when the density itself is not smooth. (Based on Ben's 2017 Ph.D. thesis)

SAMER DWEIK, UBC
[Monday June 7 / lundi 7 juin, 16:00]

CHRISTIAN KETTERER, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:00]
Glued spaces and lower curvature bounds

First I will survey some classical theorems about glued spaces and lower curvature bounds for Riemannian manifolds. Then I will present a recent result together with Vitali Kapovitch and Karl-Theodor Sturm showing that in the class of Alexandrov spaces equipped with a semi-concave weight the Riemannian curvature-dimension condition (RCD) is preserved under gluing constructions with optimal lower curvature bounds. The RCD condition, a synthetic notion of Ricci curvature bounded from below, is introduced by means of optimal transport.

MAXIME JACKY P. LABORDE, Université de Paris
[Tuesday June 8 / mardi 8 juin, 12:30]
An augmented Lagrangian method for transportation distance with bulk/interface interactions

Recently, Monsaingeon introduced a new optimal transport problem on a closed bounded domain defined via a dynamical Benamou-Brenier formulation. The model handles differently the motion in the interior and on the boundary, and penalizes the transfer of mass between the two. Taking advantage of the dynamical formulation, in this talk we will present a numerical method to compute this problem using an augmented Lagrangian method. This algorithm extends the ALG2 method introduced by Benamou-Brenier to solve the classical optimal transport problem. This is a joint work with Thomas Gallouët and Léonard Monsaingeon.

HUGO LAVENANT, Bocconi University
[Monday June 7 / lundi 7 juin, 12:30]
The Branching Schrödinger Problem

It is now well understood that regularized (a.k.a. entropic) optimal transport is linked to entropy minimization with respect to the law of the Brownian motion: this is the Schrödinger problem. I will present an ongoing work with Aymeric Baradat (CNRS, Lyon) where we explain how models of *regularized* unbalanced optimal transport are linked to entropy minimization with respect to the law of the *branching* Brownian motion.

NAM LE, Indiana University
[Tuesday June 8 / mardi 8 juin, 13:30]
Approximating minimizers of the Rochet-Chone functional with non-quadratic costs by solutions of singular Abreu equations

The Rochet-Chone model for the monopolist problem in product line design is a variational problem with a convexity constraint. This constraint renders serious challenges in numerically computing its minimizers, and calls for robust approximation schemes. In this talk, we show that, for a full range of q, minimizers of the Rochet-Chone functional with a convexity constraint in two dimensions can be approximated in the uniform norm by solutions of singular, fourth order Abreu equations that arise in extremal metrics in complex geometry.

ROBERT MCCANN, University of Toronto
[Tuesday June 8 / mardi 8 juin, 17:30]
Maximizing the sum of angles between pairs of lines in Euclidean space

Choose N unoriented lines through the origin of $\mathbf{R}^{d+1}$. Suppose each pair of lines repel each other with a force whose strength is independent of the (acute) angle between them, so that they prefer to be orthogonal to each other. However, unless $N \leq d+1$, it is impossible for all pairs of lines to be orthogonal. What then are their stable configurations? An unsolved conjecture of Fejes Toth (1959) asserts that the lines should be equidistributed as evenly as possible over an orthonormal basis in $\mathbf{R}^{d+1}$. By modifying the force to make it increase as a power of the distance, we show the analogous claim to be true for all positive powers if we are only interested in local stability, and for sufficiently large powers if we require global stability.

These results represent joint work with Tongseok Lim (of Purdue University's Krannert School of Management).

ABBAS MOMENI, Carleton University
[Tuesday June 8 / mardi 8 juin, 14:00]
Supports of extremal doubly stochastic measures and the uniqueness of the Kantorovitch optimizer

Our objective in this talk is to provide a practical necessary and nearly sufficient condition for a set to support an extremal doubly stochastic measure. We then present sufficient conditions for uniqueness of solutions of the Kantorovitch problem even though such plans may not be generally concentrated on graphs.

LEVON NURBEKYAN, UCLA
[Monday June 7 / lundi 7 juin, 16:30]
Parameter identification for chaotic dynamical systems via optimal transport

Parameter identification determines the essential system parameters required to build real-world dynamical systems by fusing crucial physical relationships and experimental data. However, the data-driven approach faces main difficulties, such as a lack of observational data, discontinuous or inconsistent time trajectories, and noisy measurements. The ill-posedness of the inverse problem comes from the chaotic divergence of the forward dynamics. Motivated by the challenges, we shift from the Lagrangian particle perspective to the state space flow field's Eulerian description. Instead of using pure time trajectories as the inference data, we treat statistics accumulated from the Direct Numerical Simulation (DNS) as the observable, whose continuous analog is the steady-state probability density function (PDF) of the corresponding Fokker–Planck equation (FPE). We reformulate the original parameter identification problem as a data-fitting, PDE-constrained optimization problem. An upwind scheme based on the finite-volume method that enforces mass conservation and positivity preserving is used to discretize the forward problem. We present theoretical regularity analysis for evaluating gradients of optimal transport costs and introduce three different formulations for efficient gradient calculation. Numerical results using the quadratic Wasserstein metric from optimal transport demonstrate this novel approach's robustness for chaotic dynamical system parameter identification.

GEOFF SCHIEBINGER, University of British Columbia
[Monday June 7 / lundi 7 juin, 13:30]
Towards a Mathematical Theory of Development

New measurement technologies like single-cell RNA sequencing are bringing 'big data' to biology. In this talk we show how optimal transport can be applied to analyze time-courses of high-dimensional gene expression data. Our ultimate goal is to develop these tools into a mathematical theory of developmental biology. We aim to answer questions like *How does a stem cell transform into a muscle cell, a skin cell, or a neuron? How can we reprogram a skin cell into a neuron?* We model a developing population of cells with a curve in the space of probability distributions on a high-dimensional gene expression space. We design algorithms to recover these curves from samples at various time-points and we collaborate closely with experimentalists to test these ideas on real data.

DAVE SCHNEIDER, University of Saskatchewan
[Monday June 7 / lundi 7 juin, 17:00]
Kac goes to work: Stochastic processes as probes of the architecture of plant root systems

The past decade has seen a rapid development of data-driven plant breeding strategies based on the two significant technological developments – high throughput DNA sequencing and the use of high resolution digital imaging to estimate quantitative traits related to plant architecture. Imaging above-ground structures such as shoots, leaves and flowers has developed rapidly. In contrast, below-ground structures are much more difficult to study. In part, this difficulty is associated with the lack of mathematical tools to characterize multi-scale, dendridic structures such as plant root systems. The focus of this talk, inspired by the analytical results of Kac, van den Berg and many others in the area of spectral geometry, is to describe a computational and statistical methodology that employs stochastic processes as quantitative measurement tools suitable for characterizing images of multi-scale dendritic structures. The substrate for statistical analyses in Wasserstein space are hitting distributions obtained by Monte Carlo simulation. The practical utility of this approach is demonstrated using 2D images of sorghum roots of different genetic backgrounds and grown in different environments. The work presented here is the result of collaborations with Young-Heon Kim, Hugo Lavenant, Brendan Pass, Yujie Pei and Geoff Schiebinger.

ADOLFO VARGAS-JIMENEZ, University of Alberta
[Tuesday June 8 / mardi 8 juin, 13:00]
Monge solutions and uniqueness in multi-marginal optimal transport via graph theory

In this talk, we will focus on the multi-marginal optimal transport problem with surplus $b(x_1, \dots, x_m) = \sum_{\{i,j\} \in P} x_i \cdot x_j$, where $P \subseteq Q := \{\{i,j\} : i,j \in \{1,2,...m\}, i \neq j\}$. We associate each surplus of this type with a graph with m vertices, whose set of edges is indexed by P. We then provide a natural reformulation of the problem in a graph theory approach, and establish uniqueness and Monge solution results for two general classes of surplus functions. In particular, these classes encapsulate the Gangbo and Święch surplus and the surplus $\sum_{i=1}^{m-1} x_i \cdot x_{i+1} + x_m \cdot x_1$, whose origin lies in the time discretization of Arnold's variational interpretation of the incompressible Euler equation. This is joint work with Brendan Pass.

TING-KAM LEONARD WONG, University of Toronto
[Tuesday June 8 / mardi 8 juin, 16:30]
Pseudo-Riemannian geometry embeds information geometry in optimal transport

Optimal transport and information geometry both study geometric structures on spaces of probability distributions. Optimal transport characterizes the cost-minimizing movement from one distribution to another, while information geometry originates from coordinate-invariant properties of statistical inference. Their connections and applications in statistics and machine learning have started to gain more attention. We show that the pseudo-Riemannian framework of Kim and McCann, a geometric perspective on the fundamental Ma-Trudinger-Wang (MTW) condition in the regularity theory of optimal transport maps, encodes the dualistic structure of statistical manifold which is a generalization of Riemannian geometry. Some examples are given to illustrate the framework. This is joint work with Jiaowen Yang (Facebook).

KELVIN SHUANGJIAN ZHANG, École Normale Supérieure de Paris
[Monday June 7 / lundi 7 juin, 13:00]
Strong duality of the principal-agent problem with bilinear preferences and its application to characterize the solutions

The principal-agent problem is one of the central problems in microeconomics. Rochet and Choné (1998) reduced the multi-dimensional principal-agent problem with bilinear preferences to a concave maximization over the set of convex functions. We introduce a new duality and use it to characterize solutions to this problem. This is joint work with Robert J. McCann.

Quantum Mathematics
Mathématiques quantiques

Org: Steven Rayan (Saskatchewan) and/et **William Witczak-Krempa** (Montréal)

Schedule/Horaire

Wednesday June 9 — **mercredi 9 juin**

10:00 - 10:30	Joseph Maciejko (University of Alberta), *Hyperbolic band theory* (p. 211)
10:30 - 11:00	Theo Johnson-Freyd (Dalhousie University / Perimeter Institute), *Classification of topological orders* (p. 210)
12:30 - 13:00	Meng Cheng (Yale University), *Fractionalization and anomaly in symmetry-enriched topological phases* (p. 209)
13:00 - 13:30	Maissam Barkeshli (University of Maryland), *Anomalies in (2+1)D fermionic topological phases and (3+1)D state sums for fermionic SPTs* (p. 209)
13:30 - 14:00	Juven Wang (Harvard University), *Ultra Unification: QFT Beyond the Standard Model* (p. 212)
14:00 - 14:30	Chong Wang (Perimeter Institute), *Stiefel liquids: possible non-Lagrangian quantum criticality from intertwined orders* (p. 212)

Friday June 11 — **vendredi 11 juin**

10:00 - 10:30	David Kribs (University of Guelph), *Operator theory and distinguishing quantum states with LOCC* (p. 210)
10:30 - 11:00	Kaori Tanaka (University of Saskatchewan), *Topological superconductivity in quasicrystals* (p. 211)
12:30 - 13:00	Luc Vinet (Université de Montréal / CRM), *Entanglement of Free Fermions on Graphs* (p. 212)
13:00 - 13:30	Cihan Okay (University of British Columbia), *A hidden variable model for universal quantum computation with magic states on qubits* (p. 211)
13:30 - 14:00	Sébastien Lord (University of Ottawa), *Secure Software Leasing Without Assumptions* (p. 210)
15:00 - 15:30	Artur Sowa (University of Saskatchewan), *Quantum applications of harmonic analysis on the group of positive rationals* (p. 211)
15:30 - 16:00	Jinglei Zhang (Institute for Quantum Computing), *SU(2) hadrons on a quantum computer* (p. 213)
16:00 - 16:30	Peter Kristel (University of Manitoba), *Connes fusion of the free fermions on the circle* (p. 210)

Abstracts/Résumés

MAISSAM BARKESHLI, University of Maryland
[Wednesday June 9 / mercredi 9 juin, 13:00]
Anomalies in (2+1)D fermionic topological phases and (3+1)D state sums for fermionic SPTs

I will describe a way to compute anomalies in general (2+1)D fermionic topological phases. First, a mathematical characterization of symmetry fractionalization for (2+1)D fermionic topological phases is presented, and then this data will be used to define a (3+1)D state sum for a topologically invariant path integral that depends on a generalized spin structure and G bundle on a 4-manifold. This path integral is a cobordism invariant and describes a (3+1)D fermion symmetry-protected topological state (SPT). The special case of time-reversal symmetry with $T^2 = -1^F$ gives a $\mathbb{Z}_{16}$ invariant of the 4D Pin$^+$ smooth bordism group, and gives an example of a state sum that can distinguish exotic smooth structure.

MENG CHENG, Yale University
[Wednesday June 9 / mercredi 9 juin, 12:30]
Fractionalization and anomaly in symmetry-enriched topological phases

I will discuss recent results in the theory of symmetry-enriched topological phases, with a focus on the (2+1) case. I will review the classification of symmetry-enriched topological order and present general formula to compute relative 't Hooft anomaly for bosonic topological phases. I will also discuss partial results for fermionic topological phases and open questions.

THEO JOHNSON-FREYD, Dalhousie University and Perimeter Institute
[Wednesday June 9 / mercredi 9 juin, 10:30]
Classification of topological orders

Topological orders have a mathematical axiomatization in terms of their higher fusion categories of extended operators; the characterizing property of these higher fusion categories is that they are satisfy a nondegeneracy condition. After overviewing some of the higher category theory that goes into this axiomatization, I will describe what we do and don't know about the classification of topological orders in various dimensions.

DAVID KRIBS, University of Guelph
[Friday June 11 / vendredi 11 juin, 10:00]
Operator theory and distinguishing quantum states with LOCC

In this talk, I'll discuss my work with collaborators on a fundamental topic in quantum information: Given a known set of quantum states, when can two parties distinguish the states under the restricted and hybrid classical-quantum communication setting called local (quantum) operations and classical communication (LOCC). I'll show how we've been able to make use of some tools from operator theory and operator algebras to develop techniques that solve certain subproblems, and briefly discuss our other ongoing and related work. This talk is based on joint works with Comfort Mintah, Michael Nathanson, and Rajesh Pereira.

PETER KRISTEL, University of Manitoba
[Friday June 11 / vendredi 11 juin, 16:00]
Connes fusion of the free fermions on the circle

A conformal net on S^1 is an assignment $\mathcal{A} : \{\text{open subsets of } S^1\} \to \{\text{von Neumann algebras acting on } \mathcal{F}\}$, which satisfies a slew of axioms motivated by quantum field theory. In this talk, I will consider the free fermionic conformal net. In this case, the Hilbert space $\mathcal{F}$ is the Fock space generated by the positive energy modes of square-integrable spinors on the circle $L^2(S^1, \mathbb{S})$; and the von Neumann algebras are Clifford algebras generated by those elements of $L^2(S^1, \mathbb{S})$ whose support lies in $I \subset S^1$. After going over this construction, I will argue that given an open interval $I \subset S^1$, one can equip $\mathcal{F}$ with the structure of $\mathcal{A}(I)$-$\mathcal{A}(I)$-bimodule. I will then outline the construction of a canonical isomorphism of bimodules $\mathcal{F} \boxtimes_{\mathcal{A}(I_-)} \mathcal{F} \to \mathcal{F}$, where $\boxtimes_{\mathcal{A}(I_-)}$ stands for the Connes fusion product over the algebra assigned to the lower semi-circle I_-. If time permits, I will discuss some (anticipated) applications of this isomorphism, for example in string geometry, or in the construction of the free fermion *extended* topological field theory.

SÉBASTIEN LORD, University of Ottawa
[Friday June 11 / vendredi 11 juin, 13:30]
Secure Software Leasing Without Assumptions

Quantum cryptography is known for enabling functionalities that are unattainable using classical information alone. Recently, Secure Software Leasing (SSL) has emerged as one of these areas of interest. Given a circuit C from a circuit class, SSL produces an encoding of C that enables a recipient to evaluate C and also enables the originator of the software to later verify that the software has been returned, meaning that the recipient has relinquished the possibility to further use the software. Such a functionality is unachievable using classical information alone, since it is impossible to prevent a user from keeping a copy of the software. Recent results have shown the achievability of SSL using quantum information for compute-and-compare

functions (a generalization of point functions). However, these prior works all make use of setup or computational assumptions. We show that SSL is achievable for compute-and-compare circuits without any assumptions.

We proceed by studying quantum copy-protection, which is a notion related to SSL, but where the encoding procedure inherently prevents a would-be quantum software pirate from splitting a single copy of an encoding for C into two parts each allowing a user to evaluate C. Using quantum message authentication codes, we show that point functions can be copy-protected without any assumptions against one honest and one malicious evaluator. We then show that a generic honest-malicious copy-protection scheme implies SSL. By prior work, this yields SSL for compute-and-compare functions.

This is joint work with Anne Broadbent, Stacey Jeffery, Supartha Podder, and Aarthi Sundaram.

JOSEPH MACIEJKO, University of Alberta
[Wednesday June 9 / mercredi 9 juin, 10:00]
Hyperbolic band theory

The notions of Bloch wave, crystal momentum, and energy bands are commonly regarded as unique features of crystalline materials with commutative translation symmetries. Motivated by the recent realization of hyperbolic lattices in circuit QED, I will present a hyperbolic generalization of Bloch theory, based on ideas from Riemann surface theory and algebraic geometry. The theory is formulated despite the non-Euclidean nature of the problem and concomitant absence of commutative translation symmetries. The general theory will be illustrated by examples of explicit computations of hyperbolic Bloch wavefunctions and bandstructures.

CIHAN OKAY, Bilkent University
[Friday June 11 / vendredi 11 juin, 13:00]
A hidden variable model for universal quantum computation with magic states on qubits

A central question in quantum information theory is to determine physical resources required for quantum computational speedup. In the model of quantum computation with magic states classical simulation algorithms based on quasi-probability distributions, such as discrete Wigner functions, are used to study this question. For quantum systems of odd local dimension it has been known that negativity in the Wigner function can be seen as a computational resource. The case of qubits, however, resisted a similar approach for some time since the nice properties of Wigner functions for odd dimensional systems no longer hold for qubits. In our recent work we construct a hidden variable model, which replaces the Wigner function representation, for qubit systems where any quantum state can be represented by a probability distribution over a finite state space and quantum operations correspond to Bayesian update of the probability distribution. When applied to the model of quantum computation with magic states the size of the state space only depends on the number of magic states. This is joint work with Michael Zurel and Robert Raussendorf; Phys. Rev. Lett. 125, 260404 (2020).

ARTUR SOWA, University of Saskatchewan
[Friday June 11 / vendredi 11 juin, 15:00]
Quantum applications of harmonic analysis on the group of positive rationals

Harmonic analysis on the multiplicative group of positive rational numbers ($\mathbb{Q}_+$) has not been part of the common quantum-theoretic toolkit. In this talk, I will discuss how it lends itself to the analysis of operators in $\ell_2(\mathbb{N})$, in some cases leading to spectacular new insights into their spectral properties. I will also discuss its application in a study of the Bose-Hubbard model, i.e. a model of an array of bosons with the nearest-neighbour interactions. The Fourier transform on $\mathbb{Q}_+$ uncovers the model's unobvious symmetries and surprising connections with other structures. In addition, I will report a rigorous, albeit computer-assisted, proof of the existence of quantum phase transitions in finite quantum systems of this type. The study of the Bose-Hubbard model has been carried out in collaboration with Prof. Jonas Fransson (Department of Physics and Astronomy, University of Uppsala).

KAORI TANAKA, University of Saskatchewan
[Friday June 11 / vendredi 11 juin, 10:30]
Topological superconductivity in quasicrystals

Majorana fermions – charge-neutral spin-1/2 particles that are their own antiparticles – have been detected in one- and two-dimensional topological superconductors. Due to the non-Abelian exchange statistics that they obey, Majorana fermions open the door to new and powerful methods of quantum information processing. Motivated by the recent experimental discovery of superconductivity in a quasicrystal, we study the possible occurrence of non-Abelian topological superconductivity (TSC) in two-dimensional quasicrystals by the same mechanism as in crystalline counterparts. We show that the TSC phase can be realised in Penrose and Ammann-Beenker quasicrystals, where the Bott index is unity. Furthermore, we confirm the existence of Majorana zero modes along the surfaces and in a vortex at the centre of the system, consistently with the bulk-boundary correspondence.

LUC VINET, C R M
[Friday June 11 / vendredi 11 juin, 12:30]
Entanglement of Free Fermions on Graphs

The entanglement of free fermions on Hamming graphs will be discussed. This will be used to showcase how tools of algebraic combinatorics such as the Terwilliger algebra are well suited for this analysis. The usefulness of a Heun operator generalization will also be stressed and extensions to other association schemes will be mentioned.

CHONG WANG, Perimeter Institute
[Wednesday June 9 / mercredi 9 juin, 14:00]
Stiefel liquids: possible non-Lagrangian quantum criticality from intertwined orders

We propose a new type of critical quantum liquids, dubbed Stiefel liquids, based on 2+1 dimensional Wess-Zumino-Witten models on target space SO(N)/SO(4). We show that the well known deconfined quantum critical point and U(1) Dirac spin liquid are unified as two special examples of Stiefel liquids, with N=5 and N=6, respectively. Furthermore, we conjecture that Stiefel liquids with $N > 6$ are non-Lagrangian, in the sense that the theories do not (at least not easily) admit any weakly-coupled UV completion. Such non-Lagrangian states are beyond the paradigm of parton gauge theory familiar in the study of exotic quantum liquids in condensed matter physics. The intrinsic absence of mean-field construction also makes it difficult to decide whether a non-Lagrangian state can emerge from a specific UV system (such as a lattice spin system). For this purpose we hypothesize that a quantum state is emergible from a lattice system if its quantum anomalies match with the constraints from the (generalized) Lieb-Schultz-Mattis theorems. Based on this hypothesis, we find that some of the non-Lagrangian Stiefel liquids can indeed be realized in frustrated quantum spin systems, for example, on triangular or Kagome lattice, through the intertwinement between non-coplanar magnetic orders and valence-bond-solid orders.

JUVEN WANG, Harvard University
[Wednesday June 9 / mercredi 9 juin, 13:30]
Ultra Unification: QFT Beyond the Standard Model

Strong, electromagnetic, and weak forces were unified in the Standard Model (SM) with spontaneous gauge symmetry breaking. These forces were further conjectured to be unified in a simple Lie group gauge interaction in the Grand Unification (GUT). Here I propose a theory beyond the SM and GUT by adding new gapped Topological Phase Sectors consistent with the nonperturbative global anomaly matching and cobordism constraints (especially from the baryon minus lepton number B - L, the electroweak hypercharge Y, and the mixed gauge-gravitational anomaly). Gapped Topological Phase Sectors are constructed via symmetry extension, whose low energy contains unitary Lorentz invariant topological quantum field theories (TQFTs): either 3+1d non-invertible TQFT (long-range entangled gapped phase), or 4+1d invertible or non-invertible TQFT

(short-range or long-range entangled gapped phase), or right-handed neutrinos, or their combinations. We propose that a new high-energy physics frontier beyond the conventional 0d particle physics relies on the new Topological Force and Topological Matter including gapped extended objects (gapped 1d line and 2d surface operators or defects, etc., whose open ends carry deconfined fractionalized particle or anyonic string excitations). I will also fill in the dictionary between math, quantum field theory (QFT), and condensed matter terminology, and elaborate more on the nonperturbative global anomalies of Z2, Z4, Z16 classes useful for beyond SM. Work is based on arXiv:2012.15860, arXiv:2008.06499, arXiv:2006.16996, arXiv:1910.14668.

JINGLEI ZHANG, Institute for Quantum Computing
[Friday June 11 / vendredi 11 juin, 15:30]
SU(2) hadrons on a quantum computer

Lattice gauge theories are relevant in many fields of physics, and simulations with quantum computers can become a powerful tool to study them, especially in regimes inaccessible to classical numerical methods. In particular, non-Abelian gauge theories, which among other things describe fundamental particles' interactions, are of great interest. In this talk I will discuss the first quantum simulation of a non-Abelian lattice gauge theory that includes dynamical matter. I will show how the theory is formulated in order to include colour degrees of freedom, and how this allows for the existence of baryons in the model, which do not exist in Abelian theories. A quantum computation of the low-lying spectrum of the model is performed on an IBM superconducting platform using a variational quantum eigensolver. This proof-of-concept demonstration was made possible by a resource-efficient approach in the design of the quantum algorithm, and lays out the foundation for further development of the field. This talk is based on arXiv:2102.08920.

Quantum information theory
Théorie de l'information quantique

Org: Jason Crann (Carleton) and/et **David Kribs** (Guelph)

Schedule/Horaire

Wednesday June 9	**mercredi 9 juin**
10:00 - 10:30	Sang-Gyun Youn (Seoul National University), *Irreducibly SU(2)-covariant quantum channels* (p. 217)
10:30 - 11:00	Jitendra Prakash (University of Copenhagen), *Constant-sized robust self-tests for states and measurements of unbounded dimensions* (p. 215)
13:00 - 13:30	Sarah Plosker (Brandon University), *Quantum theoretic aspects of spin unitary matrices* (p. 215)
13:30 - 14:00	Jeremy Levick (Institute for Quantum Computing/University of Guelph), *Mixed Unitary Rank* (p. 215)
14:00 - 14:30	Hadi Salmasian (University of Ottawa), *Monogamy of Entanglement Games on Unitary Groups* (p. 216)

Thursday June 10	**jeudi 10 juin**
10:00 - 10:30	Mizanur Rahaman (BITS Pilani Goa), *Bisynchronous Games and Positively Factorizable Maps* (p. 216)
10:30 - 11:00	Ivan Todorov (University of Delaware), *A quantum sandwich theorem* (p. 216)
12:30 - 13:00	Li Gao (Technical University of Munich), *Complete logarithmic Sobelev inequalities* (p. 214)
13:00 - 13:30	Rajesh Pereira (University of Guelph), *Correlation Matrices in Quantum Information Theory* (p. 215)
13:30 - 14:00	Martti Karvonen (University of Ottawa), *Neither contextuality nor non-locality admits catalysts* (p. 215)
14:00 - 14:30	Nathaniel Johnston (Mount Allison University), *Completely positive completely positive maps (and a resource theory for non-negativity of quantum amplitudes)* (p. 214)

Abstracts/Résumés

LI GAO, Technical University of Munich
[Thursday June 10 / jeudi 10 juin, 12:30]
Complete logarithmic Sobelev inequalities

Quantum Markov semigroups are noncommutative generalization of Markov process, which models the time evolution of dissipative open quantum systems. For both classical and quantum Markov semigroups, modified log Sobolev inequality serves as a powerful tool to study the convergence property via the exponential decay of entropy. In this talk, I'll present some recent progress on complete bounded versions of modified log-Sobelev inequalities for finite dimensional quantum Markov semigroups. This talk is based on a joint work with Cambyse Rouze.

NATHANIEL JOHNSTON, Mount Allison University
[Thursday June 10 / jeudi 10 juin, 14:00]
Completely positive completely positive maps (and a resource theory for non-negativity of quantum amplitudes)

We examine quantum states which are non-negative mixtures of pure states with non-negative amplitudes (in a fixed basis) and the channels which preserve them. These states are exactly those that are completely positive (CP), and we show how several standard properties of CP matrices, such as the CP-rank, correspond to physical properties of these states. We also introduce the family of quantum channels that preserve CP states, which we call *completely positive completely positive (CPCP)*, since quantum channels are also (very confusingly) called completely positive. We show that CP quantum states and the CPCP maps that preserve them constitute a (physically well-motivated) quantum resource theory analogous to that of quantum

entanglement. Finally, we investigate several ways of measuring how resourceful a state is in this theory (which roughly means how far away it is from being CP).

MARTTI KARVONEN, University of Ottawa
[Thursday June 10 / jeudi 10 juin, 13:30]
Neither contextuality nor non-locality admits catalysts

Bell's theorem rules out local hidden-variable theories of quantum mechanics. This is due to the phenomena of non-locality: given n-parties sharing some quantum states, there is no joint probability distribution on all possible measurements that explains the outcomes observed when each party chooses a fixed measurement. Contextuality can be seen as the same phenomenon (i.e. inability to glue pairwise compatible probability distributions into a joint one) without the assumption of spatial separation.

Non-locality of quantum mechanics is often seen as arising from entanglement, but entanglement and non-locality are not quite the same resource. In this talk we discuss one such discrepancy. Entanglement famously allows for catalysts: there are states that can be used to catalyze an otherwise impossible local transformation. More formally, there are quantum states ρ_1, ρ_2 such that no (LOCC-)transformation $\rho_1 \to \rho_2$ exists but $\psi \otimes \rho_1$ can be transformed to $\psi \otimes \rho_2$.

In this talk we show that such catalysts do not exist for contextuality nor for non-locality. To do so, we first recap what contextuality and non-locality are as features of correlations, and then discuss what does it mean to transform such correlations to others. This lets us formalize the no-catalysis result, which states that if there is a transformation $d \otimes e \to d \otimes f$, then there is a transformation $e \to f$ as well.

JEREMY LEVICK, University of Guelph
[Wednesday June 9 / mercredi 9 juin, 13:30]
Mixed Unitary Rank

We discuss the mixed unitary rank of a mixed unitary channel: the smallest number of unitaries required to express the channel in Choi-Kraus form. We present an upper bound on mixed unitary rank in terms of the Choi rank and the dimension of an associated operator system, and present a class of examples based on mutually unbiased bases which exhibit a large gap between mixed unitary rank and Choi rank.

RAJESH PEREIRA, University of Guelph
[Thursday June 10 / jeudi 10 juin, 13:00]
Correlation Matrices in Quantum Information Theory

Correlation matrices are positive semidefinite matrices which have all of their diagonal entries equal to one. In this talk, we explore some applications of correlation matrices to topics in quantum information such as quantum channels, coherence and Bell's inequalities. The key common mathematical theme between all of these topics is the interplay between the set of correlation matrices and the subset formed by taking the convex hull of the rank-one correlation matrices.

SARAH PLOSKER, Brandon University
[Wednesday June 9 / mercredi 9 juin, 13:00]
Quantum theoretic aspects of spin unitary matrices

We consider quantum theoretic aspects of spin systems, which are finite sets of anticommuting selfadjoint unitary matrices, and of complete order isomorphisms between the operator systems generated by two spin systems, a concept related to the quantum interpolation problem. We also connect our findings to recent developments on the topic of free spectrahedra and matrix convex sets.

JITENDRA PRAKASH, University of Copenhagen
[Wednesday June 9 / mercredi 9 juin, 10:30]
Constant-sized robust self-tests for states and measurements of unbounded dimensions

We consider correlations, $p_{n,x}$, arising from measuring a maximally entangled state using n measurements with two outcomes each, constructed from n projections that add up to some scalar times an identity. We show that the correlations $p_{n,x}$ robustly self-test the underlying states and measurements. To achieve this, we lift the group-theoretic Gowers-Hatami based approach for proving robust self-tests to a more natural algebraic framework. A key step is to obtain an analogue of the Gowers-Hatami theorem allowing to perturb an "approximate" representation of the relevant algebra to an exact one. As a corollary, we exhibit a constant-size self-test for measurements of unbounded dimension as well as all maximally entangled states with odd local dimension. (This is a joint work with Laura Mančinska and Christopher Schafhauser.)

MIZANUR RAHAMAN, BITS Pilani KK Birla Goa Campus
[Thursday June 10 / jeudi 10 juin, 10:00]
Bisynchronous Games and Positively Factorizable Maps

Bisynchronous games are a special class of non-local games played by Alice and Bob against a referee where players can use entanglement as a resource to optimize their winning probability. In this talk, I will introduce these games and the corresponding probability densities which we call bisynchronour correlations. We establish a close connection with the theory of quantum permutation groups and these correlations. Moreover, when the number of inputs is equal to the number of outputs, each bisynchronous correlation gives rise to a unital quantum channel which will be shown to be factorizable in the sense of Haagerup-Musat. Motivated from this

finding, we further generalize the concept of factorizability and introduce a new class of quantum channels that we call **positively factorizable**. It turns out that there is a close connection between the convex sets in Euclidian space containing self-dual cones and the existence of these maps. In this context, we

find new examples of matrices that are non-negative but not CPSD (completely positive semidefinite). This talk is based on two separate works with Vern Paulsen and Jeremy Levick.

HADI SALMASIAN, University of Ottawa
[Wednesday June 9 / mercredi 9 juin, 14:00]
Monogamy of Entanglement Games on Unitary Groups

A Monogamy of Entanglement game (MOE) is a tripartite game in which two isolated parties (Bob and Charlie) try to predict the outcome of the measurement done by the third party (Alice) based on the information that they receive about Alice's measurement. The MOE games have recently found a number of applications, e.g. in uncloneable encryption. In this talk we will investigate MOE games in which Alice's measurement is determined by a randomly chosen point on the unitary group. Computing the winning probability thresholds of this MOE game lead to interesting questions involving the Haar measure. This talk is based on a joint work (in progress) with A. Broadbent, A. Mahmoud, and M. Nevins.

IVAN TODOROV
[Thursday June 10 / jeudi 10 juin, 10:30]
A quantum sandwich theorem

The classical sandwich theorem in combinatorial optimisation, due to Grötschel, Lovász and Schrijver, is an inclusion chain between three convex corners arising canonically from a given graph, and plays a cornerstone role in classical zero-error information theory. In this talk, based on a joint work with Gareth Boreland and Andreas Winter, I will describe a non-commutative version of this result, suited to the context of zero-error quantum information theory, and based on non-commutative graphs.

The viewpoint we employ leads to new quantum versions of the classical Lovász number of a graph and to improved bounds on the zero-error capacity of a quantum channel.

SANG-GYUN YOUN, Seoul National University
[Wednesday June 9 / mercredi 9 juin, 10:00]
Irreducibly SU(2)-covariant quantum channels

Quantum channel is one of the most fundamental objects in quantum information theory, and group symmetry has been considered important resources to analyze quantum channels. Conservation of irreducible group symmetries has been studied for quantum channels in various contexts. In particular, geometric structures of the set of all irreducibly covariant quantum channels have been clarified very recently. The main aim of this talk is to present detailed information-theoretic properties of irreducibly SU(2)-covariant quantum channels of low rank (less than or equal to 3). For example, we present complete characterizations of PPT property, entanglement-breaking property, degradability, Holevo information in this class. Moreover, this approach gives us a new example of additivity violation of the coherent information.

Recent Advances in Complex and Harmonic Analysis
Progrès récents dans l'analyse harmonique complexe

Org: **Ilia Binder** (Toronto), **Damir Kinzebulatov** (Laval) and/et **Javad Mashreghi** (Laval)

Schedule/Horaire

Wednesday June 9 — **mercredi 9 juin**

10:00 - 10:30	Paul Gauthier (Université de Montréal), *A characterization of non-tangential cluster sets for holomorphic functions $f : D \to D$.* (p. 220)
10:30 - 11:00	Rasul Shafikov (University of Western Ontario), *Local polynomial convexity of Levi-flat hypersurfaces* (p. 222)
12:30 - 13:00	Eric Schippers (University of Manitoba), *Transmission of harmonic functions of finite Dirichlet norm* (p. 222)
13:00 - 13:30	Maëva Ostermann (Université Laval), *Une approche abstraite de la conjecture de Crouzeix* (p. 221)
13:30 - 14:00	Maxim Burke (University of Prince Edward Island), *Analytic order-isomorphisms of countable dense subsets of the unit circle* (p. 219)
14:00 - 14:30	Frédéric Morneau-Guérin (TÉLUQ), *Inégalités du type Young pour les espaces Lp(G,w)* (p. 221)
16:00 - 16:30	Adi Glucksam (University of Toronto), *Integral mean spectrum and its complex extension- a survey* (p. 220)
16:30 - 17:00	William Verreault (Université Laval), *Nonlinear Oscillatory Expansions of Analytic functions* (p. 223)

Thursday June 10 — **jeudi 10 juin**

10:00 - 10:30	Thomas Ransford (Université Laval), *Decay of singular inner functions* (p. 222)
10:30 - 11:00	Marek Ptak (University of Krakow), *Generalized multipliers for left-invertible analytic operators* (p. 222)
12:30 - 13:00	Ludovick Bouthat (Université Laval), *Some results about infinite L-matrices* (p. 219)
13:00 - 13:30	William Ross (University of Richmond), *The Smirnov class of de Branges–Rovnyak spaces* (p. 222)
13:30 - 14:00	Pierre-Olivier Parisé (Université Laval), *Power-series methods in de Branges-Rovnyak spaces* (p. 221)
14:00 - 14:30	Eugene Bilokopytov (University of Alberta), *Multiplier Algebras, big and small* (p. 218)
16:00 - 16:30	Alan Sola (Stockholm University), *Stable polynomials and bounded rational functions of several variables* (p. 223)
16:30 - 17:00	Javad Mashreghi (Université Laval), *Approximation by modified Taylor polynomials* (p. 221)

Friday June 11 — **vendredi 11 juin**

10:00 - 10:30	Ignacio Uriarte-Tuero (University of Toronto), *The Krzyz conjecture revisited* (p. 223)
10:30 - 11:00	Alex Stokolos (Georgia Southern University), *On univalent polynomials* (p. 223)
12:30 - 13:00	Alexander Brudnyi (University of Calgary) (p. 219)
13:00 - 13:30	Galia Dafni (Concordia University), *Vanishing mean oscillation* (p. 220)
15:00 - 15:30	Kodjo Raphaël Madou (Université Laval), *On admissible singular drifts of symmetric α-stable process* (p. 220)
15:30 - 16:00	Almaz Butaev (University of Calgary), *On locally uniform domains in $\mathbb{R}^n$* (p. 219)
16:00 - 16:30	Wenbo Li (University of Toronto), *Quasisymmetric Embeddability of Weak Tangents* (p. 220)

Abstracts/Résumés

EUGENE BILOKOPYTOV, University of Alberta
[Thursday June 10 / jeudi 10 juin, 14:00]
Multiplier Algebras, big and small

In this talk we consider multiplier algebras of Banach spaces of continuous and analytic functions. In particular, conditions which guarantee that such a multiplier algebra is big (i.e. non-separable) is presented. We also discuss some situations when a Banach space of functions has no non-constant multipliers. In order to construct an example of such a space over an arbitrary separable metric space we use a generalization of a result by Mashreghi and Ransford about realization of every separable Banach space as a Banach space of analytic functions.

LUDOVICK BOUTHAT, Université Laval
[Thursday June 10 / jeudi 10 juin, 12:30]
Some results about infinite L-matrices

We know that any linear application from $\mathbb{C}^n$ to $\mathbb{C}^n$ can be described with an $n \times n$ square matrix. The space ℓ^2 of square-summable sequences indexed by the natural numbers is a generalization of $\mathbb{C}^n$ to infinite dimension. We find that the operators, in the case of ℓ^2, can be described by infinite matrices. However, not all infinite matrices gives us an operator on ℓ^2. It is natural to wonder which infinite matrices are a representation of an operator on ℓ^2, and what is their norm. Because of their applications in the problem of the caracterisation of the multipliers in the weighted Dirichlet spaces, we restrict ourselves to the case of infinite L-matrices. An infinite positive L-matrix is an infinite matrix which is defined by a sequence $(a_n)_{n\geq 0}$ of positive real numbers and which is of the form

$$A = \begin{pmatrix} a_0 & a_1 & a_2 & a_3 & \dots \\ a_1 & a_1 & a_2 & a_3 & \dots \\ a_2 & a_2 & a_2 & a_3 & \dots \\ a_3 & a_3 & a_3 & a_3 & \dots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{pmatrix}.$$

We present some conditions on the sequence $(a_n)_{n\geq 0}$ for A to be an operator on ℓ^2 and we present a particular set of L-matrices for which we are able to exactly determine the norm. We also show some new results about L-matrices with lacunary coefficients.

ALEXANDER BRUDNYI, University of Calgary
[Friday June 11 / vendredi 11 juin, 12:30]

MAXIM BURKE, University of Prince Edward Island
[Wednesday June 9 / mercredi 9 juin, 13:30]
Analytic order-isomorphisms of countable dense subsets of the unit circle

For functions in $C^k(\mathbb{R})$ which commute with a translation, we prove a theorem on approximation by entire functions which commute with the same translation, with a requirement that the values of the entire function and its derivatives on a specified countable set belong to specified dense sets. Using this theorem, we show that if A and B are countable dense subsets of the unit circle $T \subseteq \mathbb{C}$ with $1 \notin A$, $1 \notin B$, then there is an analytic function $h\colon \mathbb{C} \setminus \{0\} \to \mathbb{C}$ that restricts to an order isomorphism of the arc $T \setminus \{1\}$ onto itself and satisfies $h(A) = B$ and $h'(z) \neq 0$ when $z \in T$. This answers a question of P. M. Gauthier.

ALMAZ BUTAEV, University of Calgary
[Friday June 11 / vendredi 11 juin, 15:30]
On locally uniform domains in $\mathbb{R}^n$

I will talk about different definitions of locally uniform domains $\Omega \subset \mathbb{R}^n$. Specifically, we will be interested in the characterization of locally uniform domains in terms of the quasi-hyperbolic metric and their role as extension domains for Goldberg's bmo(Ω) space. This is joint work with Galia Dafni (Concordia University).

GALIA DAFNI, galia.dafni@concordia.ca
[Friday June 11 / vendredi 11 juin, 13:00]
Vanishing mean oscillation

Sarason (1975) characterized the closure of the uniformly continuous functions in $\mathrm{BMO}(\mathbb{R})$ by the uniform vanishing of the mean oscillation (VMO) over intervals, as the size of the intervals shrinks to zero. Variations of VMO exist in the literature under the same and different notations. In joint work with Almut Burchard (Toronto) and Ryan Gibara (Laval), we consider VMO defined using a basis of open sets in $\mathbb{R}^n$ and study the continuity of rearrangements on this space. In joint work with Almaz Butaev (Calgary), looking at the nonhomogenous BMO space (Goldberg's bmo) on a domain $\Omega \subset \mathbb{R}^n$, we formulate conditions determining "vanishing at the boundary" and "vanishing at infinity", and obtain approximation and extension results for functions satisfying these conditions when Ω is an (ϵ, δ) domain.

PAUL GAUTHIER, Université de Montréal
[Wednesday June 9 / mercredi 9 juin, 10:00]
A characterization of non-tangential cluster sets for holomorphic functions $f : D \to D$.

For a holomorphic function in the unit disc, denote the non-tangential (=angular) cluster set as $C_{NT}(f, 1)$. Harald Woracek asked for a description (other than the definition) of sets A, for which $A = C_{NT}(f, 1)$, for some holomorphic function in the unit disc and bounded by 1. We characterize such sets as the union of a countable increasing sequence of continua in the closed disc.

ADI GLUCKSAM, University of Toronto
[Wednesday June 9 / mercredi 9 juin, 16:00]
Integral mean spectrum and its complex extension- a survey

In a celebrated paper from 1998 N. Makarov related the integral mean spectrum and the packing spectrum. In this talk I will discuss the complex version of the integral means spectrum, and present similar known relations for the complex case.

WENBO LI, University of Toronto
[Friday June 11 / vendredi 11 juin, 16:00]
Quasisymmetric Embeddability of Weak Tangents

A weak tangent of a metric space is a "blown up" space (in the sense of pointed Gromov-Hausdorff limit) near a point. In this talk, we study the quasisymmetric embeddability of weak tangents of metric spaces.

We first show that quasisymmetric embeddability is hereditary, i.e., if X can be quasisymmetrically embedded into Y, then every weak tangent of X can be quasisymmetrically embedded into some weak tangent of Y, given that X is proper and doubling. However, the converse implication is not true in general ; we will illustrate this with a counterexample. In special situations, we are able to show that the embeddability of weak tangents implies the global or local embeddability of the ambient space. Finally, we apply our results on limit sets of Kleinian groups and visual spheres of expanding Thurston maps.

KODJO RAPHAËL MADOU, Université Laval
[Friday June 11 / vendredi 11 juin, 15:00]
On admissible singular drifts of symmetric α-stable process

We consider the problem of existence of a (unique) weak solution to the SDE describing symmetric α-stable process with a locally unbounded drift $b : \mathbb{R}^d \to \mathbb{R}^d$, $d \geq 3$, $1 < \alpha < 2$. In this talk, b belongs to the class of weakly form-bounded vector fields, the class providing the L^2 theory of the non-local operator behind the SDE, i.e. $(-\Delta)^{\frac{\alpha}{2}} + b \cdot \nabla$. It contains as proper sub-classes other classes of singular vector fields studied in the literature in connection with this operator, such as the Kato class, the weak $L^{d/(\alpha-1)}$ class and the Campanato-Morrey class (in general, such b makes invalid the standard heat kernel estimates in terms of the heat kernel of the fractional Laplacian). We show that the operator $(-\Delta)^{\frac{\alpha}{2}} + b \cdot \nabla$ with weakly form-bounded b admits a realization as (minus) Feller generator, and that the probability measures determined by the Feller semigroup (uniquely in appropriate sense) admit description as weak solutions to the corresponding SDE. The proof is based on detailed regularity theory of $(-\Delta)^{\frac{\alpha}{2}} + b \cdot \nabla$ in L^p, $p > d - \alpha + 1$.

The talk is based on joint work with Damir Kinzebulatov (Université Laval).

JAVAD MASHREGHI, Laval University
[Thursday June 10 / jeudi 10 juin, 16:30]
Approximation by modified Taylor polynomials

It is known that the sequence of Taylor polynomials may diverge in the local Dorochlet spaces. However, the sequence of Fejer means is a good remedy and it converges to the initial function in the norm. Another possibility is to modify the last term of Taylor polynomials and create a convergent sequence. We study this phenomenon as an orthogonal projection to the subspace of polynomials of degree at most n.

FRÉDÉRIC MORNEAU-GUÉRIN, Université TELUQ
[Wednesday June 9 / mercredi 9 juin, 14:00]
Inégalités du type Young pour les espaces Lp(G,w)

Au cours de cet exposé, nous présenterons deux généralisations de l'inégalité de Young pour les espaces pondérés de fonctions de p-ième puissance intégrable définies sur un groupe localement compact.

MAËVA OSTERMANN, Université Laval
[Wednesday June 9 / mercredi 9 juin, 13:00]
Une approche abstraite de la conjecture de Crouzeix

En 2004, Crouzeix a conjecturé que l'inégalité $\|P(T)\| \leq 2\|P\|_{W(T)}$ tient pour toute matrice T et tout polynôme P. Récemment, Crouzeix et Palencia ont montré que cette inégalité tient avec $1 + \sqrt{2}$ à la place de 2. En partant de leur résultat, je proposerai dans cet exposé une approche abstraite de cette conjecture.

Travail conjoint avec Thomas Ransford.

PIERRE-OLIVIER PARISÉ, Université Laval
[Thursday June 10 / jeudi 10 juin, 13:30]
Power-series methods in de Branges-Rovnyak spaces

In this talk, I will introduce the logarithmic power-series method, which applies to the sequence of Taylor partial sums of a holomorphic function in the unit disk $\mathbb{D}$. I will show that there exist a de Branges-Rovnyak space $\mathcal{H}(b)$, a function $f \in \mathcal{H}(b)$ such that the polynomials are dense in $\mathcal{H}(b)$, but the Taylor series of the function f is not summable with respect to the logarithmic

power-series method. I will also discuss an abstract result in operator theory showing that if one regular summability method includes another for scalar sequences, then it automatically does so for certain Banach-space-valued sequences too. Lastly, I will present consequences of this result to summability in $\mathcal{H}(b)$ with respect to other power-series methods.

Joint work with Javad Mashreghi and Thomas Ransford.

MAREK PTAK, University of Agriculture, Kraków, Poland
[Thursday June 10 / jeudi 10 juin, 10:30]
Generalized multipliers for left-invertible analytic operators

A left-invertible analytic operator T can be seen as a multiplication operator by an independent variable on a space of analytic functions with values in kernel of the adjoint $\ker T^*$ of the given operator T. We define generalized multipliers for T as "analytic" sequences, whose coefficients are bounded operators on $\ker T^*$. The generalized multipliers form a Banach algebra and characterize the commutant of the left-invertible analytic operator.

Joint work with Piotr Dymek and Artur Płaneta.

THOMAS RANSFORD, Université Laval
[Thursday June 10 / jeudi 10 juin, 10:00]
Decay of singular inner functions

A singular inner function is a holomorphic function on the unit disk of the form

$$S(z) := \exp\Big(-\int \frac{e^{it}+z}{e^{it}-z}\,d\mu(t)\Big),$$

where μ is a finite positive Borel measure on the unit circle that is singular with respect to Lebesgue measure. A well-known and important property of such functions is that $\lim_{r\to 1^-} S(re^{i\theta}) = 0$ μ-almost everywhere on the unit circle. In this talk I shall discuss the rate of convergence to zero.

WILLIAM ROSS, University of Richmond
[Thursday June 10 / jeudi 10 juin, 13:00]
The Smirnov class of de Branges–Rovnyak spaces

In this joint work with Emmanuel Fricain and Andreas Hartmann, we show that every function in certain de Branges–Rovnyak spaces can be written as the quotient of two multipliers of these spaces. These types of results hold for many other analytic function spaces such as the Hardy and Dirichlet spaces.

ERIC SCHIPPERS, University of Manitoba
[Wednesday June 9 / mercredi 9 juin, 12:30]
Transmission of harmonic functions of finite Dirichlet norm

Consider a Jordan curve in the Riemann sphere. A harmonic function with finite Dirichlet norm on the interior of the curve has non-tangential limits in a certain sense except on a negligible set. If the Jordan curve is sufficiently regular, these are also the boundary values of a harmonic function of bounded Dirichlet norm on the exterior of the curve. We call this harmonic function on the exterior the "transmission" of the original harmonic function. The transmission operator exists and is bounded if and only if the curve is a quasicircle. We will discuss transmission and related results for the Cauchy and Grunsky operators, as well as integral operators of Schiffer.

RASUL SHAFIKOV, University of Western Ontario
[Wednesday June 9 / mercredi 9 juin, 10:30]
Local polynomial convexity of Levi-flat hypersurfaces

I will discuss the problem of local polynomial convexity of Levi-flat hypersurfaces near singular points.

ALAN SOLA, Stockholm University
[Thursday June 10 / jeudi 10 juin, 16:00]
Stable polynomials and bounded rational functions of several variables

Reporting on joint work in progress with Kelly Bickel (Bucknell), Greg Knese (Washington University), and James Pascoe (Florida) I will discuss several problems related to polynomials in several variables having no zeros in a prescribed domain in $\mathbb{C}^n$ and to rational functions having such polynomials as their denominators.

ALEX STOKOLOS, Georgia Southern University
[Friday June 11 / vendredi 11 juin, 10:30]
On univalent polynomials

We present a method which seems to produce univalent in $\mathbb{D}$ polynomials as well as T-symmetrized version of them. This is a joint work with Dmitriy Dmitrishin and Mihai Tohaneanu.

IGNACIO URIARTE-TUERO, University of Toronto
[Friday June 11 / vendredi 11 juin, 10:00]
The Krzyz conjecture revisited

The conjecture of Krzyż, concerning the largest possible value of the Taylor coefficient a_n $(n \geq 1)$ of a non-vanishing analytic function from the unit disk into the unit disk, has been open since 1968 in spite of the information available on the structure of extremal functions.

The purpose of this talk is to report on partial progress regarding the conjecture. We collect various conditions that the coefficients of an extremal function (and also the zeros of some polynomials associated with it) must satisfy and show that each one of these properties is equivalent to the conjecture itself.

This improves or complements a number of earlier findings by other authors and may hopefully provide several possible starting points for attempts at proving the conjecture.

WILLIAM VERREAULT, Université Laval
[Wednesday June 9 / mercredi 9 juin, 16:30]
Nonlinear Oscillatory Expansions of Analytic functions

We extend results of Coifman, T. Qian et al. on the Blaschke unwinding series expansion of an entire function f, a nonlinear analogue of Fourier series with a wide range of practical applications. To do this, we consider an unwinding of f by elements in the closed unit ball of H^∞. We also present convergence theorems in H^p for our unwinding series.

Recent Developments in Gröbner Geometry
Développements récents en géométrie de Gröbner

Org: **Megumi Harada**, **Jenna Rajchgot** and/et **Sergio Da Silva** (McMaster)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
12:30 - 12:50	Oliver Pechenik (University of Waterloo), *Gröbner Geometry of Schubert Polynomials Through Ice, Part I* (p. 225)
13:00 - 13:20	Anna Weigandt (University of Michigan), *Gröbner Geometry of Schubert Polynomials Through Ice, Part II* (p. 226)
13:30 - 13:50	Allen Knutson (Cornell University), *Partial ordinary, and bumpless, pipe dreams* (p. 225)
14:00 - 14:20	Informal Socialization (p. 226)
16:00 - 16:20	Patricia Klein (University of Minnesota), *A proof of a conjecture about Schubert determinantal ideals* (p. 224)
16:30 - 16:50	Emmanuel Neye (University of Saskatchewan), *Gröbner bases for Kazhdan-Lusztig ideals* (p. 225)
17:00 - 17:20	Alexander Woo (University of Idaho), *Delta-Springer fibers* (p. 226)

Wednesday June 9	**mercredi 9 juin**
12:30 - 12:50	Laura Escobar (Washington University St. Louis), *Gröbner bases for a family of symmetric determinantal ideals* (p. 224)
13:00 - 13:20	Colleen Robichaux (UIUC), *Castelnuovo-Mumford regularity and Kazhdan-Lusztig varieties* (p. 225)
13:30 - 13:50	Zach Hamaker (University of Florida), *Grobner degeneration for skew-symmetric matrices* (p. 224)
14:00 - 14:20	Alex Yong (UIUC), *Hilbert-Samuel multiplicities of Schubert varieties* (p. 226)

Abstracts/Résumés

LAURA ESCOBAR, Washington University in St. Louis
[Wednesday June 9 / mercredi 9 juin, 12:30]
Gröbner bases for a family of symmetric determinantal ideals

I will discuss a class of combinatorially-defined polynomial ideals which are generated by minors of a generic symmetric matrix. Each ideal in the class encodes the coordinates and equations for neighborhoods of certain type C Schubert varieties at torus fixed points. Our main result gives Gröbner bases for these ideals. The first part of the talk will focus on motivation and connections to both the Schubert variety literature and the commutative algebra literature. Then I will discuss our Gröbner basis result as well as combinatorial formulas for their multigraded Hilbert series in terms of pipe dreams.

This is joint work with Alex Fink, Jenna Rajchgot, and Alexander Woo.

ZACH HAMAKER, University of Florida
[Wednesday June 9 / mercredi 9 juin, 13:30]
Grobner degeneration for skew-symmetric matrices

Since the introduction of Grobner geometry in Knutson and Miller's breakthrough work on matrix Schubert varieties, the technique has been employed to study many related spaces. In a major advance building on previous work joint with the speaker, Marberg and Pawlowski used these methods to describe K-theory representatives for skew-symmetric matrix Schubert varieties. In this talk, we explore further work in this setting. This includes joint work with Anna Weigandt.

PATRICIA KLEIN, University of Minnesota
[Tuesday June 8 / mardi 8 juin, 16:00]
A proof of a conjecture about Schubert determinantal ideals

Knutson and Miller (2005) showed that the Fulton generators form Gröbner bases of Schubert determinantal ideals under any anti-diagonal term order. Gröbner bases of diagonal term orders have proved much more elusive. Recently, Hamaker, Pechenik, and Weigandt conjectured that a generating set they named the CDG generators form a diagonal Gröbner basis if and only if 8 permutation patterns are avoided. In this talk, we will use the relationship between Gorenstein liaison and geometric vertex decomposition, explored the speaker's previous work with Rajchgot, to gain intuition for why these 8 patterns must be avoided and to sketch a proof of the conjecture.

ALLEN KNUTSON, Cornell University
[Tuesday June 8 / mardi 8 juin, 13:30]
Partial ordinary, and bumpless, pipe dreams

First I'll define "partial pipe dreams", which is somewhere between a permutation and a pipe dream for that permutation. To each such D I'll associate a variety $Y_D \subseteq Mat_n$ that is correspondingly between a matrix Schubert variety and a coordinate subspace. Then the inductive theorem is that if we revlex the matrix variable at an "outer corner" (i,j) of D, Y_D degenerates to a union of various $Y_{D'}$ where the pipe dream part of D' is that of D plus one more tile at (i,j). Then I'll talk about the projective dual statement, lexing partial bumpless pipe dreams. Time permitting, I'll talk about joint work in progress with P. Zinn-Justin interpolating between the ordinary and bumpless pictures.

EMMANUEL NEYE, University of Saskatchewan
[Tuesday June 8 / mardi 8 juin, 16:30]
Gröbner bases for Kazhdan-Lusztig ideals

Schubert determinantal ideals are a class of generalized determinantal ideals which include the classical determinantal ideals. In this talk, we use the approach of "Gröbner basis via linkage" to give a new proof of a well-known result of Knutson and Miller: the essential minors of every Schubert determinantal ideal form a Gröbner basis with respect to a certain term order. We also adapt the Gröbner basis via linkage technique to the multigraded setting and use this to show that the essential minors of every Kazhdan-Lusztig ideal form a Gröbner basis with respect to a certain term order, thereby giving a new proof of a result of Woo and Yong.

OLIVER PECHENIK, University of Waterloo
[Tuesday June 8 / mardi 8 juin, 12:30]
Gröbner Geometry of Schubert Polynomials Through Ice, Part I

The geometric naturality of Schubert polynomials and the related combinatorics of pipe dreams was established by Knutson and Miller (2005) via antidiagonal Gröbner degeneration of matrix Schubert varieties. We consider instead diagonal Gröbner degenerations. In this dual setting, Knutson, Miller, and Yong (2009) obtained alternative combinatorics for the class of vexillary matrix Schubert varieties. We will discuss general diagonal degenerations, relating them to an older formula of Lascoux (2002) in terms of the 6-vertex ice model. Lascoux's formula was recently rediscovered by Lam, Lee, and Shimozono (2018), as "bumpless pipe dreams." We will explain this connection and discuss conjectures and progress towards understanding diagonal Gröbner degenerations of matrix Schubert varieties.

COLLEEN ROBICHAUX, University of Illinois at Urbana-Champaign
[Wednesday June 9 / mercredi 9 juin, 13:00]
Castelnuovo-Mumford regularity and Kazhdan-Lusztig varieties

We give an explicit formula for the degree of a vexillary Grothendieck polynomial. We apply our work to compute the Castelnuovo-Mumford regularity of certain matrix Schubert varieties. We also derive a formula for the regularity of mixed one-sided ladder determinantal ideals. This is joint work with Jenna Rajchgot and Anna Weigandt.

INFORMAL SOCIALIZATION,
[Tuesday June 8 / mardi 8 juin, 14:00]

ANNA WEIGANDT, University of Michigan
[Tuesday June 8 / mardi 8 juin, 13:00]
Gröbner Geometry of Schubert Polynomials Through Ice, Part II

The geometric naturality of Schubert polynomials and the related combinatorics of pipe dreams was established by Knutson and Miller (2005) via antidiagonal Gröbner degeneration of matrix Schubert varieties. We consider instead diagonal Gröbner degenerations. In this dual setting, Knutson, Miller, and Yong (2009) obtained alternative combinatorics for the class of vexillary matrix Schubert varieties. We will discuss general diagonal degenerations, relating them to an older formula of Lascoux (2002) in terms of the 6-vertex ice model. Lascoux's formula was recently rediscovered by Lam, Lee, and Shimozono (2018), as "bumpless pipe dreams." We will explain this connection and discuss conjectures and progress towards understanding diagonal Gröbner degenerations of matrix Schubert varieties.

ALEXANDER WOO, University of Idaho
[Tuesday June 8 / mardi 8 juin, 17:00]
Delta-Springer fibers

We introduce a family of compact varieties $Y_{n,\lambda,s}$ that generalize the Springer fibers in type A. We show that they have a paving by affines and use properties of this paving to give a presentation for their cohomology rings. These cohomology rings have an action of S_n with the top dimensional cohomology being an induced Specht module. In the case where $\lambda = (1^k)$ and $s = k$, the cohomology ring is the ring constructed by Haglund-Rhoades-Shimozono whose graded Frobenius characteristic is the symmetric function $\omega(\Delta'_{e_{k-1}} e_n(q, 0))$.

This is joint work with Sean Griffin (ICERM/UC Davis) and Jake Levinson (SFU).

ALEX YONG, University of Illinois at Urbana-Champaign
[Wednesday June 9 / mercredi 9 juin, 14:00]
Hilbert-Samuel multiplicities of Schubert varieties

I'll revisit some older (still unsolved) conjectures with Li Li (Oakland University) and Alexander Woo (University of Idaho) on Hilbert-Samuel multiplicities of Schubert varieties. This talk concerns Grobner and tangent cone degenerations of Kazhdan-Lusztig ideals/varieties.

Recent advances in theory and applications of functional differential equations
Progrès récents dans la théorie et les applications des équations différentielles fonctionnelles

Org: Victor Leblanc (Ottawa)

Schedule/Horaire

Thursday June 10	**jeudi 10 juin**
10:00 - 10:30	Michael Mackey (McGill University), *State dependent delays induce novel dynamics in gene regulatory systems* (p. 228)
10:30 - 11:00	Teresa Faria (University of Lisbon), *Stability for nonautonomous linear delayed differential systems* (p. 227)
12:30 - 13:00	Connell McCluskey (Wilfrid Laurier University), *Modelling the growth of variants* (p. 229)
13:00 - 13:30	Huaiping Zhu (York University) (p. 229)
13:30 - 14:00	Felicia Magpantay (Queen's University), *Lyapunov-Razumikhin techniques for state-dependent delay differential equations* (p. 228)
14:00 - 14:30	André Longtin (University of Ottawa), *Non-monotonic complexity with increasing numbers of delays* (p. 228)
16:00 - 16:30	Xingfu Zou (Western University), *On a predator-prey system with digestion delay and anti-predation strategy* (p. 229)
16:30 - 17:00	Gail Wolkowicz (McMaster University), *A Decay-Consistent Model of Population Growth and Competition with Delay* (p. 229)
17:00 - 17:30	Kevin Church (McGill University), *Computer-assisted proof of Hopf bifurcation in functional differential equations of mixed type* (p. 227)
17:30 - 18:00	Victor LeBlanc (University of Ottawa), *Degenerate Hopf Bifurcation in DDEs and Endemic Bubbles* (p. 227)

Abstracts/Résumés

KEVIN CHURCH, McGill University
[Thursday June 10 / jeudi 10 juin, 17:00]
Computer-assisted proof of Hopf bifurcation in functional differential equations of mixed type

I will present a computational approach to Hopf bifurcation verification for functional differential equations of mixed type. The verification of a steady state, imaginary eigenvalues and their transversality amounts to a finite-dimensional problem which we rigorously solve using a Newton-Kantorovich-type theorem. To prove the imaginary eigenvalues are simple and that there is no resonance, we use some a priori estimates and rigorous contour integration of the characteristic equation to count all eigenvalues in a neighbourhood of the imaginary axis. As an application, we prove some results on periodic traveling waves in the Fisher equation with a nonlocal reaction term. This is joint with with Jean-Philippe Lessard.

TERESA FARIA, University of Lisbon
[Thursday June 10 / jeudi 10 juin, 10:30]
Stability for nonautonomous linear delayed differential systems

We study the stability of general nonautonomous linear differential equations with infinite delays. Delay independent criteria, as well as criteria depending on the size of bounded diagonal delays are established. Our results encompass DDEs with discrete and distributed delays, and enhance some recent achievements in the literature.

VICTOR LEBLANC, University of Ottawa
[Thursday June 10 / jeudi 10 juin, 17:30]
Degenerate Hopf Bifurcation in DDEs and Endemic Bubbles

We consider 2-parameter families of retarded functional differential equations (RFDE) which undergo Hopf bifurcation from an equilibrium, but for which the crossing condition of the Hopf theorem is violated (such a degeneracy is codimension 2). We classify the possible bifurcation diagrams in terms of the nonlinearities of the RFDE, and we apply the results to an SIS disease model incorporating delayed behavioral response.

ANDRÉ LONGTIN, University of Ottawa
[Thursday June 10 / jeudi 10 juin, 14:00]
Non-monotonic complexity with increasing numbers of delays

We investigate transitions to simple dynamics in first-order nonlinear differential equations with multiple delays. Multiple delays can destabilize fixed points and promote high-dimensional chaos, but many delays can also induce stabilization onto simpler dynamics. We focus on this behaviour as a function of the number of delays. Dynamical complexity is shown to depend on the precise distribution of delays. A narrow spacing between individual delays favours chaotic behaviour, while a lower density of delays enables stable periodic or fixed point behaviour. During complexity decrease, the number of roots of the characteristic equation around the fixed point that have a positive real part decreases. These roots behave in fact in a similar manner to the Lyapunov exponents and the Kolmogorov-Sinai entropy for these multi-delay systems, and can thus serve as a proxy for those dynamical invariants. Our results rely on a novel method to estimate the Lyapunov spectrum of multi-delay nonlinear systems, as well as on permutation entropy computations. Surprisingly, complexity collapse upon adding more delays can occur abruptly through an inverse period-doubling sequence. Our results shed light on the dynamical effects of the transition from discrete to continuous delay distributions. We also discuss the implications of our results for reservoir computing.

MICHAEL MACKEY, McGill University
[Thursday June 10 / jeudi 10 juin, 10:00]
State dependent delays induce novel dynamics in gene regulatory systems

This talk will review models for the bacterial regulation of gene expression and function for both repressible (negative feedback) and inducible (positive feedback) genes, and the nature of the nonlinearities involved. I argue that both the delays due to transcription of DNA to mRNA and translation of mRNA to produce protein are likely state dependent. The consequences of this turn out to be relatively astonishing in the sense that the state dependence of these delays can lead to completely new dynamical behaviors that are not present when the delays are constant. In both inducible and repressible systems the state dependence in the delays may lead to the appearance of more steady states as well as unexpected bifurcations not present when the delays are constant.

This is joint work with T. Gedon, A. Humphries, H.-O Walther, and Z. Wang.

FELICIA MAGPANTAY, Queen's University
[Thursday June 10 / jeudi 10 juin, 13:30]
Lyapunov-Razumikhin techniques for state-dependent delay differential equations

We present theorems for the Lyapunov and asymptotic stability of the steady state solutions to general state-dependent delay differential equations (DDEs) using Lyapunov-Razumikhin methods. These theorems build upon the previous work of Hale and Verduyn Lunel (1993), and Barnea (1969) which were mainly aimed at equations with simpler delay terms (e.g. constant and time-dependent delays), and are less applicable to state-dependent DDEs such as the following model equation,

$$\dot{u}(t) = \mu u(t) + \sigma u(t - a - cu(t)).$$

The stability region $\Sigma_\star$ of the zero solution to this model problem is known, and it is the same for both the constant delay ($c = 0$) and state-dependent delay ($c \neq 0$) cases. Using our results we can prove the asymptotic stability of the zero solution to this model problem in parts of $\Sigma_\star$, considerably expanding upon the work of Barnea who proved Lyapunov stability for the simpler $\mu = c = 0$ constant delay case. Similar techniques are used to derive a condition for global asymptotic stability of the zero solution to the model problem, and bounds on periodic solutions when the zero solution is unstable. This is joint work with A.R. Humphries

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CONNELL MCCLUSKEY, Wilfrid Laurier University
[Thursday June 10 / jeudi 10 juin, 12:30]
Modelling the growth of variants

There is a slow growth in the number of variants of concern for COVID-19. We model this growth as proportional to the number of infected individuals worldwide. Once new variants appear, they contribute to the spread.
Let $M(t)$ be the number of variants, and let $i(t.m)$ be the number of individuals infected with variant m at time t. Then

$$\frac{dM}{dt}(t) = \int_{m=0}^{M(t)} p(m)\, i(t,m)\, dm,$$

where $p(m)$ is the rate at which variant m slowly produces new variants.
What can we do with it ? What impact do vaccines have on $M(t)$?

GAIL WOLKOWICZ, McMaster University
[Thursday June 10 / jeudi 10 juin, 16:30]
A Decay-Consistent Model of Population Growth and Competition with Delay

We derive an alternative expression for a delayed logistic equation in which the rate of change in the population involves a growth rate that depends on the population density during an earlier time period. In our formulation, the delay in the growth term is consistent with the rate of instantaneous decline in the population given by the model. Our formulation is a modification of [Arino et al., J. Theoret. Biol. 241(1):109–119, 2006] by taking the intraspecific competition between the adults and juveniles into account. We provide a complete global analysis showing that no sustained oscillations are possible. A threshold giving the interface between extinction and survival is determined in terms of parameters in the model. Our approach for analyzing the global dynamics incorporates the theory of chain transitive sets and the comparison theorem for cooperative delay differential equations. We extend our delayed logistic equation to a system modeling the competition of two species. For the competition model we provide results on local stability, bifurcation diagrams, and adaptive dynamics. Assuming that the species with shorter delay produces fewer newborns than the species with longer delay, we show that there is a critical value τ^* such that the evolutionary trend is to take the delay as close to τ^* as possible.
This is joint work with Chiu-Ju Lin and Ting-Hao Hsu

HUAIPING ZHU, York University
[Thursday June 10 / jeudi 10 juin, 13:00]

XINGFU ZOU, University of Western Ontario
[Thursday June 10 / jeudi 10 juin, 16:00]
On a predator-prey system with digestion delay and anti-predation strategy

In this talk, I will present a predator-prey model incorporated with both cost and benefit from the prey's anti-predation response, together with a time delay in the transfer of biomass from the prey to the predator after predation. The model is a system

of delay differential equations (DDEs). By analyzing this nonlinear DDE system, we obtain some insights on how the anti-predation response level (indirect effect) and the biomass transfer delay jointly affect the population dynamics; particularly we show how the nonlinearity in the predation term mediated by the fear effect affects the long term dynamics of the model system. These results seem to suggest a need to revisit some existing predator-prey models in the literature by incorporating the indirect effect and biomass transfer delay.

Representations of p-adic groups and Langlands correspondences
Représentations de groupes p-adiques et correspondances de Langlands

Org: Karol Koziol (Michigan) and/et **Monica Nevins** (Ottawa)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
10:00 - 11:00	Jessica Fintzen (Cambridge/Duke/IAS), *Representations of p-adic groups* (p. 232)
12:30 - 13:30	Daniel Le (Purdue), *A mod p local-global compatibility result for generic Fontaine-Laffaille representations* (p. 233)
13:30 - 14:00	Robert Cass (Harvard), *Geometrization of mod p Hecke algebras* (p. 232)
16:00 - 16:30	Adèle Bourgeois (Carleton), *Supercuspidal L-packets of G_2 in Relation to Those of SO_8 and PSO_8* (p. 232)
16:30 - 17:00	Eran Assaf (Dartmouth), *Existence of Invariant Norms in p-adic Representations of $GL_2(F)$ with Large Weights* (p. 231)

Wednesday June 9	**mercredi 9 juin**
10:00 - 11:00	Clifton Cunningham (Calgary), *Vogan's geometric perspective on local L-packets and A-packets* (p. 232)
12:30 - 13:30	Tom Haines (Maryland), *Geometry of affine Schubert varieties and applications* (p. 233)
13:30 - 14:00	Gil Moss (Utah), *Toward a local Langlands correspondence in families* (p. 234)
16:00 - 17:00	Sean Howe (Utah), *p-adic automorphic forms for GL_2* (p. 233)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Jeff Adler (American), *Regular Bernstein blocks* (p. 231)
13:00 - 13:30	Stella Gastineau (Boston College), *Diving into the Shallow End* (p. 232)
13:30 - 14:00	Peter Latham (Ottawa), *The inertial Langlands correspondence* (p. 233)
16:00 - 17:00	Rachel Ollivier (UBC), *The pro-p-Iwahori Hecke Ext-algebra of $SL(2,\mathbb{Q}_p)$* (p. 234)

Abstracts/Résumés

JEFF ADLER, American University
[Thursday June 10 / jeudi 10 juin, 12:30]
Regular Bernstein blocks

Let G be a connected reductive group over a nonarchimedean local field F. The Bernstein decomposition expresses the category of smooth, complex representations of $G(F)$ as a product of full subcategories, called Bernstein blocks, containing representations that all have the same depth. One hopes that, in some generality, a positive-depth Bernstein block for $G(F)$ will be equivalent to a depth-zero Bernstein block for $G^0(F)$, where G^0 is some twisted Levi F-subgroup of G. I will outline some cases where the hope is realized. This is joint work with Manish Mishra.

ERAN ASSAF, Dartmouth College
[Tuesday June 8 / mardi 8 juin, 16:30]
Existence of Invariant Norms in p-adic Representations of $GL_2(F)$ with Large Weights

Let F be a finite extension of $\mathbb{Q}_p$ and let q be the cardinality of its residue field. The Breuil-Schneider conjecture for $G = GL_n(F)$ predicts a necessary and sufficient condition for the existence of an invariant norm on $\rho \otimes \pi$, where ρ is an irreducible algebraic

representation of G and π is an irreducible smooth representation of G over $\overline{F}$. The conjecture is still open, even when $n = 2$, if π is a principal series representation. In this case, assuming π is unramified and $\rho = \mathrm{Sym}^k \otimes \det^m$, it had been verified by Breuil and De Ieso when $k < q$, and these results have been extended to the range $k < q^2/2$, imposing some technical conditions on π and k. In the talk we will provide a new proof of these results, and remove some of the technical conditions.

ADÈLE BOURGEOIS, Carleton University
[Tuesday June 8 / mardi 8 juin, 16:00]
Supercuspidal L-packets of G_2 in Relation to Those of SO_8 and PSO_8

Little is known about the Local Langlands Correspondence (LLC) for the exceptional group G_2 over a non-archimedean local field. However, G_2 can be realized as a twisted endoscopic group of PSO_8, which in turn is closely related to SO_8. Because the LLC for SO_8 is well-known, the idea is to establish connections between the L-parameters and L-packets of $\mathrm{SO}_8, \mathrm{PSO}_8$ and G_2. In particular, one can start by restricting their attention to supercuspidal L-parameters and L-packets in order to take advantage of Kaletha's recent parameterizations. This talk will focus on our recent progress in establishing a clear relationship between the supercuspidal L-packets of the three groups at play.

ROBERT CASS, Harvard University
[Tuesday June 8 / mardi 8 juin, 13:30]
Geometrization of mod p Hecke algebras

We will give an overview of three applications of techniques from the geometric Langlands program toward the study of mod p Hecke algebras. The first is a mod p version of the geometric Satake equivalence which provides a geometric version of Herzig's mod p Satake isomorphism. The second geometrizes an isomorphism due to Ollivier and Vignéras describing the center of the Iwahori mod p Hecke algebra. The third is joint work with Cédric Pépin and geometrizes the mod p Satake transform with respect to a general Levi subgroup.

CLIFTON CUNNINGHAM, University of Calgary
[Wednesday June 9 / mercredi 9 juin, 10:00]
Vogan's geometric perspective on local L-packets and A-packets

This talk concerns Vogan's geometric perspective on the Langlands correspondence, which identifies irreducible admissible representations of a p-adic group $G(F)$ and its pure inner forms with simple perverse sheaves on a moduli space of Langlands parameters. We will explain how to identify L-packets using this perspective and then explain Vogan's conjecture on how to identify A-packets using the geometry of this moduli space. We will then present evidence for this conjecture and progress toward a proof. This talk includes examples all these notions using unipotent representations of $\mathrm{SO}_5(F)$ and $\mathrm{G}_2(F)$.

JESSICA FINTZEN, University of Cambridge and Duke University
[Tuesday June 8 / mardi 8 juin, 10:00]
Representations of p-adic groups

The Langlands program is a far-reaching collection of conjectures that relate different areas of mathematics including number theory and representation theory. A fundamental problem on the representation theory side of the local Langlands program is the construction of all (irreducible, smooth) representations of p-adic groups.

I intend to provide an overview of our understanding of the complex and mod-ℓ representations of p-adic groups and outline recent developments and applications.

STELLA GASTINEAU, Boston College
[Thursday June 10 / jeudi 10 juin, 13:00]
Diving into the Shallow End

In 2013, Reeder-Yu gave a construction of supercuspidal representations by starting with stable characters coming from the shallowest depth of the Moy-Prasad filtration. In this talk, we will be diving deeper—but not too deep. In doing so, we will construct examples of supercuspidal representations coming from a larger class of "shallow" characters. Using methods similar to Reeder-Yu, we can begin to make predictions about the Langlands parameters for these representations.

TOM HAINES, University of Maryland
[Wednesday June 9 / mercredi 9 juin, 12:30]
Geometry of affine Schubert varieties and applications

Classical Schubert varieties are orbit-closures of a Borel subgroup acting on a partial flag variety attached to a connected reductive group. They play a central role in representation theory and combinatorics. Their geometric properties – whether they are normal, Cohen-Macaulay, or Frobenius-split ; when they are singular, and what kind of singularities arise, etc – have been intensively studied and are now well understood. Affine Schubert varieties are similar objects but attached to a loop group rather than a group. They play a role in representation theory, mathematical physics, and in geometric approaches to automorphic forms. In the last 20 years they have been studied in large part because of their connection to certain Shimura varieties through the theory of Rapoport-Zink local models. But some key geometric properties – including normality – remain somewhat mysterious to this day, at least in some positive characteristic settings. This talk will survey some recent advances in the study of affine Schubert varieties, especially the surprising fact that almost all affine Schubert varieties in "bad" positive characteristic are not normal. We will connect this to the Langlands program by explaining how these results are used to understand the geometry of certain Shimura varieties.

SEAN HOWE, University of Utah
[Wednesday June 9 / mercredi 9 juin, 16:00]
p-adic automorphic forms for GL_2

There are (at least) three natural spaces of p-adic automorphic forms for $\mathrm{GL}_2/\mathbb{Q}$: Katz-Serre p-adic modular forms (and their perfected variant), Serre's quaternionic forms, and completed cohomology. Away from p all three have the same completed Hecke algebra, while at p completed cohomology admits an action of $\mathrm{GL}_2(\mathbb{Q}_p)$ and the other two admit actions of closely related p-adic groups. For p-adic modular forms and completed cohomology, the representations of these p-adic groups appearing in a fixed eigensystem are well-understood (by the q-expansion principle and Emerton's local-global compatibility, respectively), while the structure in the quaternionic case remains more mysterious. In this talk, we explain how Pan's recent results on the ubiquity of overconvergent modular forms can be used to extract some information about this structure.

PETER LATHAM, University of Ottawa
[Thursday June 10 / jeudi 10 juin, 13:30]
The inertial Langlands correspondence

The inertial Langlands correspondence is a modification of the local Langlands correspondence which relates Bushnell–Kutzko types to representations of the inertia group. I will explain a refinement of this correspondence which includes the monodromy action of Langlands parameters. This is proved by establishing a precise connection between typical representations and the decomposition of parabolically induced representations.

DANIEL LE, Purdue University
[Tuesday June 8 / mardi 8 juin, 12:30]
A mod p local-global compatibility result for generic Fontaine-Laffaille representations

By work of Khare-Wintenberger, Colmez, Emerton, and others, the commuting actions of $\mathrm{GL}_2(\mathbb{A})$ and $\mathrm{Gal}(\overline{\mathbb{Q}}/\mathbb{Q})$ on the $\overline{\mathbf{F}}_p$-cohomology of the tower of modular curves realizes a mod p Langlands correspondence, characterized by the Eichler-Shimura relation at good primes and Colmez's Montreal functor at p. With no conjectural formulation of a mod p Langlands correspondence for $\mathrm{GL}_n(\mathbb{Q}_p)$ at present, it is natural to ask if a local $\mathrm{Gal}(\overline{\mathbb{Q}}_p/\mathbb{Q}_p)$-representation can be recovered from the corresponding $\mathrm{GL}_n(\mathbb{Q}_p)$-representation appearing in the cohomology of an appropriate adelic quotient. We give an affirmative answer in some generic Fontaine-Laffaille cases (also allowing unramified extensions of $\mathbb{Q}_p$). This is joint work with Le Hung, Morra, Park, and Qian.

GIL MOSS, University of Utah
[Wednesday June 9 / mercredi 9 juin, 13:30]
Toward a local Langlands correspondence in families

The local Langlands correspondence connects representation of p-adic groups to Langlands parameters, which are certain representations of Galois groups of local fields. In recent work with Dat, Helm, and Kurinczuk, we have shown that Langlands parameters, when viewed through the right lens, occur naturally within a moduli space over Z[1/p], and we can say some things about the geometry of this moduli space. This geometry should be reflected in the representation theory of p-adic groups, on the other side of the local Langlands correspondence. The "local Langlands in families" conjecture describes the moduli space of Langlands parameters in terms of the center of the category of representations of the p-adic group– it was proved for GL(n) in 2018. The goal of the talk is to give an overview of this picture, including current work in-progress, with some discussion of the relation to recent work of Zhu and Fargues-Scholze.

RACHEL OLLIVIER, UBC
[Thursday June 10 / jeudi 10 juin, 16:00]
The pro-p-Iwahori Hecke Ext-algebra of $SL(2,\mathbb{Q}_p)$

Given a p-adic reductive group G and its (pro-p) Iwahori-Hecke algebra H, we are interested in the link between the category of smooth representations of G and the category of H-modules. When the field of coefficients has characteristic zero this link is well understood by work of Bernstein and Borel.

In characteristic p things are still poorly understood and the role of the pro-p Iwahori-Hecke algebra H is played by a differential graded Hecke algebra. In particular, by work of Peter Schneider, the module category over the d.g. Hecke algebra is equivalent to the derived category of smooth representations of G. Unlike in the case of H, we know little about the structure of this d.g. Hecke algebra.

In this talk I will report on joint work with Peter Schneider where we study the cohomology of the d.g. Hecke algebra. When $G = SL(2,\mathbb{Q}_p)$ we now understand its structure well enough to deduce some properties of mod p representations of $SL(2,\mathbb{Q}_p)$. We also have results for certain more general groups.

Robust and model-independent finance
La finance robuste et indépendante du modèle

Org: Leonard Wong (University of Toronto)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	Ludovic Tangpi (Princeton University), *Non-Asymptotic convergence rates for the estimation of risk measures* (p. 236)
13:00 - 13:30	Ibrahim Ekren (Florida State University), *On the asymptotic optimality of the comb strategy for prediction with expert advice* (p. 235)
13:30 - 14:00	Jinniao Qiu (University of Calgary), *Stochastic Black-Scholes Equation under Rough Volatility* (p. 236)
16:00 - 16:30	Alexander Schied (University of Waterloo), *Model-free estimation of the roughness exponent of a continuous trajectory* (p. 236)
16:30 - 17:00	Martin Larsson (Carnegie Mellon University), *High-dimensional open markets in stochastic portfolio theory* (p. 235)
17:00 - 17:30	Steven Campbell (University of Toronto), *Functional portfolio optimization in stochastic portfolio theory* (p. 235)

Abstracts/Résumés

STEVEN CAMPBELL, University of Toronto
[Monday June 7 / lundi 7 juin, 17:00]
Functional portfolio optimization in stochastic portfolio theory

This talk will present a concrete and fully implementable approach to the optimization of functionally generated portfolios in stochastic portfolio theory. The main idea is to optimize over a family of rank-based portfolios parameterized by an exponentially concave function on the unit interval. This choice can be motivated by the long-term stability of the capital distribution observed in large equity markets and avoids the curse of dimensionality. The resulting optimization problem, which is convex, is flexible as various regularizations and constraints can be imposed on the generating function. Moreover, it is well-posed, and a stability estimate in terms of a Wasserstein metric of the input measure will be provided. A discretization and optimization algorithm for the problem will also be introduced and illustrated with empirical examples using CRSP data from the US stock market.

IBRAHIM EKREN, FSU
[Monday June 7 / lundi 7 juin, 13:00]
On the asymptotic optimality of the comb strategy for prediction with expert advice

For the problem of prediction with expert advice in the adversarial setting, we compute the exact leading order expansion for the long time behavior of the value function. Then, we use this expansion to prove that as conjectured in Gravin, Peres and Sivan (2016), the comb strategies are indeed asymptotically optimal for the adversary in the case of 4 experts. Joint work with Erhan Bayraktar, Xin Zhang and Yili Zhang.

MARTIN LARSSON, Carnegie Mellon University
[Monday June 7 / lundi 7 juin, 16:30]
High-dimensional open markets in stochastic portfolio theory

Stochastic portfolio theory studies investments in large equity markets. Such investments are frequently confined to an "open market": a high capitalization investment-grade subset of a much broader equity universe. We develop models for open markets

which (i) are consistent with a given invariant distribution of relative market capitalizations, (ii) lead to explicit growth-optimal portfolios, (iii) are robust to the dimensionality and specific characteristics of lower-capitalization stocks outside the investment-grade subset, and (iv) serve as a worst-case model for a robust asymptotic growth maximization problem that incorporates model ambiguity. (Joint work with David Itkin.)

JINNIAO QIU, University of Calgary
[Monday June 7 / lundi 7 juin, 13:30]
Stochastic Black-Scholes Equation under Rough Volatility

Rough volatility is a new paradigm in finance. We shall talk about the option pricing problems for rough volatility models. As the framework is non-Markovian, the value function for a European option is not deterministic; rather, it is random and satisfies a backward stochastic partial differential equation (BSPDE) or so-called stochastic Black-Scholes equation. The wellposedness of such kind of BSPDEs and associated Feynman-Kac representations will be discussed. These BSPDEs are also used to approximate American option prices. Moreover, a deep learning-based method will be investigated for the numerical approximations to such BSPDEs and associated non-Markovian pricing problems. Examples will be presented for both European and American options.

This talk is based on joint work with Christian Bayer and Yao Yao.

ALEXANDER SCHIED, University of Waterloo
[Monday June 7 / lundi 7 juin, 16:00]
Model-free estimation of the roughness exponent of a continuous trajectory

We discuss ways of characterizing the "roughness" of a trajectory by means of its p^{th} variation or its Wiener–Young Φ-variation. This gives rise to an index, which can be interpreted as the Hurst parameter of the trajectory. We analyze several examples among classical fractal functions. We also discuss new estimators for the Hurst parameter, whose consistency can be established without any probabilistic assumptions on the underlying trajectories. Our results are illustrated by means of financial time series.

Based on joint work with Xiyue Han and Zhenyuan Zhang.

LUDOVIC TANGPI, Princeton University
[Monday June 7 / lundi 7 juin, 12:30]
Non-Asymptotic convergence rates for the estimation of risk measures

Consider the problem of computing the riskiness of a financial position F written on the underlying S with respect to a general law invariant risk measure (for instance the average value at risk). In practice the true distribution of S is unknown, and one needs to resort to historical data for the computation. In this talk we present rates of convergence results to the riskiness of F(S) when the distribution of S is estimated by its empirical measure given N observations. We will present (sharp) non-asymptotic rates for both the deviation probability and the expectation of the estimation error. This talk is based on a join work with Daniel Bartl.

STUDC Research Session
Session StudC

Org: Sebastien Lord (UOttawa), **Genevieve Maalouf** (McMaster University) and/et **William Verreault** (University of Laval)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 12:55	Alexis Leroux-Lapierre (McGill University), *La théorie de la représentation des algèbres à une frontière (The representation theory of the one boundary algebras)* (p. 238)
12:55 - 13:20	Jérémie Turcotte (McGill University), *Bounding the cop number of small graphs* (p. 239)
13:20 - 13:45	Brandon Crofts (Columbia University), *Counting Solutions of $a^2 + pbc = 0$ in a Cube* (p. 237)
13:45 - 14:10	Ankai Liu (Queens University) (p. 238)
14:10 - 14:35	Raja Milad (Dalhousie University), *Harmonic Analysis on Affine groups and Continuous Wavelet Transform* (p. 239)

Friday June 11	**vendredi 11 juin**
12:30 - 12:55	Axel Turnquist (New Jersey Institute of Technology), *Optimal Transport on the Sphere* (p. 239)
12:55 - 13:20	Nick Huang (University of Toronto), *The impact of understanding definitions in students' performances* (p. 238)
13:20 - 13:45	Fatemeh Pouryahya (Ottawa) (p. 239)
13:45 - 14:10	Roghayeh Maleki (University of Regina), *FOUR DIMENSIONAL ASSOCIATION SCHEMES HAVE CYCLOTOMIC CHARACTER VALUES* (p. 238)
14:10 - 14:35	Masoomeh Akbari (University of Ottawa), *Probabilistic Transitive Closure of Fuzzy Cognitive Maps: Algorithm Enhancement* (p. 237)

Abstracts/Résumés

MASOOMEH AKBARI, University of Ottawa
[Friday June 11 / vendredi 11 juin, 14:10]
Probabilistic Transitive Closure of Fuzzy Cognitive Maps: Algorithm Enhancement

A *fuzzy cognitive map* (FCM) is made up of factors and direct impacts. In graph theory, a bipolar weighted digraph is used to model an FCM ; its vertices represent the factors, and the arcs represent the direct impacts. Each direct impact is assigned a weight in $[0, 1]$ as well as a sign (positive or negative). In the model considered in this work, each weight is interpreted as the probability of the impact. A directed walk from factor F to factor F' is interpreted as an indirect impact of F on F'. The *probabilistic transitive closure* (PTC) of an FCM (or bipolar weighted digraph) is a bipolar weighted digraph with the same set of factors, but with arcs corresponding to the indirect impacts in the given FCM and the weight of each arc equal to the probability of the indirect impact.

FCMs can serve as effective tools to study problems in various fields. They can be used to represent structured knowledge in science, engineering, and the social sciences. Transitive closure provides valuable new information for its corresponding FCM. Unfortunately, computing the PTC of an FCM is computationally hard.

In this talk, we describe a new enhancement of existing algorithms for computing PTC. We show how one can use a separating vertex to reduce the input digraph into smaller components, and how to recover the PTC of the original digraph from the PTCs of the smaller components.

This is joint work with my supervisor, Mateja Šajna.

BRANDON CROFTS, Teachers College, Columbia University
[Monday June 7 / lundi 7 juin, 13:20]
Counting Solutions of $a^2 + pbc = 0$ in a Cube

For a prime p, let $s_p(n)$ be the number of integer triples (a, b, c) which satisfy $a^2 + pbc = 0$, where a, b, c are bounded by natural number n, and p is prime. Some sequences of this form have had limited numbers of terms contributed to the OEIS, while others have had no contributions at all. A non-recursive, generalized algorithm was theorized and developed, to produce the first n terms of the sequence relating to the equation $a^2 + pbc = 0$.

NICK HUANG, University of Toronto
[Friday June 11 / vendredi 11 juin, 12:55]
The impact of understanding definitions in students' performances

"Linear algebra is so much different from the math that I have learned in high school." This is a sentence that was said by many university students in their first years. Previous studies have shown that understanding concepts, use of suitable notations in communicating ideas and attitude towards mathematics are major factors that contribute to learning linear algebra. In our study, quantitative and qualitative research is conducted on a class of first year students taking linear algebra at the University of Toronto, Scarborough in order to investigate the impact of mastery in reciting definitions, and the ability to identify and come up examples and counter examples for a particular concept in students' ability to communicate in mathematics. It is not surprising that significant correlations have been found between understanding definition and writing a proof in linear algebra. However, the story turns out to be more complicated and there are multiple factors with different levels of impact in the students' performance. Overall, even though our study supports definition focus approaches to linear algebra, it suggests that focusing on multiple representations on concepts can further improve students learning. In this talk, I will share the methodology and findings of our study. This talk is targeted to anyone with an interest in math education, especially first year instructors, and graduate students with TA responsibility can benefit from our findings.

ALEXIS LEROUX-LAPIERRE, McGill
[Monday June 7 / lundi 7 juin, 12:30]
La théorie de la représentation des algèbres à une frontière (The representation theory of the one boundary algebras)

The Temperley-Lieb algebras and their generalization play an important role both in mathematics and in physics. Their representations turn out to be interesting for certain specific values of a so-called deformation parameter q common to all those families. This talk will be concerned with the one boundary algebras (or blob algebras), a finite dimensional quotient of the affine Temperley-Lieb algebras, when q is a root of unity. More specifically, the quiver of these algebras and a characterization using Loewy diagrams of the projective modules will be given. Joint work with Yvan Saint-Aubin.

Les algèbres de Temperley-Lieb et leurs généralisations jouent un rôle important tant en mathématiques qu'en physique. Leurs représentations s'avèrent intéressantes pour certaines valeurs particulières d'un paramètre de déformation q commun à toutes ces familles. Cette présentation s'intéressera aux algèbres à une frontière (ou algèbre blob), un quotient de dimension finie des algèbres de Temperley-Lieb affines, lorsque le paramètre q est une racine de l'unité. Plus précisément, le carquois de ces algèbres et une caractérisation de certains modules projectifs sous forme de diagramme de Loewy seront donnés. Travail en collaboration avec Yvan Saint-Aubin.

Slides in french, presentation in English.

ANKAI LIU, Queens University
[Monday June 7 / lundi 7 juin, 13:45]

ROGHAYEH MALEKI, University of Regina
[Friday June 11 / vendredi 11 juin, 13:45]
FOUR DIMENSIONAL ASSOCIATION SCHEMES HAVE CYCLOTOMIC CHARACTER VALUES

In 1980, Simon P. Norton posed the Cyclotomic Eigenvalue Question (CEQ) which asks whether the entries of the character table of a commutative association scheme always lie in a cyclotomic number field. The adjacency algebras of association schemes are a special type of standard integral table algebras with integral multiplicites (SITAwIMs). Character formulas for complete graphs, strongly regular graphs, and doubly regular tournaments imply the CEQ is true in dimensions 2 and 3.

In this talk we will show that the values of irreducible characters of SITAwIMs of dimension up to 4 lie in cyclotomic number fields. We also give an example of a SITAwIM with noncyclotomic character values of dimension 5. This is joint work with Allen Herman.

RAJA MILAD, Dalhousie university
[Monday June 7 / lundi 7 juin, 14:10]
Harmonic Analysis on Affine groups and Continuous Wavelet Transform

The set of all invertible affine transformations of a two dimensional real vector space forms a locally compact group G2 that is isomorphic to the semi-direct product group formed when GL2(R) acts on R2 in the obvious manner, where GL2(R) denotes the group of 2 by 2 real matrices with nonzero determinant. We give an explicit decomposition of the left regular representation of G2 as a direct sum of infinitely many copies of a single irreducible representation. We also obtain an analog of the continuous wavelet transform associated to the representation we identify.

FATEMEH POURYAHYA, Ottawa
[Friday June 11 / vendredi 11 juin, 13:20]

JÉRÉMIE TURCOTTE, McGill University
[Monday June 7 / lundi 7 juin, 12:55]
Bounding the cop number of small graphs

We introduce the game of Cops and Robbers, played on graphs. We present recent progress on graphs which are extremal for the cop number. It is well known that the smallest connected graph for which 3 cops are needed to capture the robber is the Petersen graph. Using both formal and computational methods, we determine the minimum order of connected 4-cop-win graphs, which confirms a conjecture of Andreae (1986), and later of Baird et al. (2014), and work towards the uniqueness of such graphs. Based on joint work with Samuel Yvon.

AXEL TURNQUIST, New Jersey Institute of Technology
[Friday June 11 / vendredi 11 juin, 12:30]
Optimal Transport on the Sphere

Recently, much progress has been made using wide-stencil finite-difference schemes to provide convergence frameworks for optimal transport and related Monge-Ampère-type PDE problems. One particular merit of these methods lies in their ability to deal with viscosity solutions, as first hinted at in a 1991 paper by Barles-Souganidis. However, these methods have so far not been adapted to geometries other than subsets of Euclidean space. Recent applications including global moving-mesh methods in meteorology and the reflector antenna problem have inspired work on the optimal transport problems on the sphere, which utilize the squared geodesic cost and a negative logarithmic cost, respectively. Here, we construct a numerical convergence

framework for optimal transport on the sphere with both cost functions in mind. We show that a wide-stencil finite-difference scheme can be constructed to solve the optimal transport problem on the sphere that has guaranteed convergence to a modified PDE in both smooth and non-smooth cases, where in the latter case we must construct underestimating schemes. We supplement this theory with a particular construction of the scheme which satisfies the hypotheses of the convergence theorem and demonstrate its effectiveness at computing heretofore unsolved problems on the sphere.

Stochastic partial differential equations
Équations aux dérivées partielles stochastiques

Org: Raluca Balan (Ottawa) and/et **Yaozhong Hu** (Alberta)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
12:30 - 13:00	David Nualart (University of Kansas), *Convergence of densities for the stochastic heat equation* (p. 242)
13:00 - 13:30	Xiaoming Song (Drexel University), *Spatial averages for the Parabolic Anderson model driven by rough noise* (p. 243)
13:30 - 14:00	Mickey Salins (Boston University), *Global solutions for the stochastic reaction-diffusion equation with polynomially dissipative forcing* (p. 242)
16:00 - 16:30	Yimin Xiao (Michigan State University), *Regularity Properties and Propagation of Singularities of the Stochastic Wave Equation* (p. 243)
16:30 - 17:00	Dongsheng Wu (University of Alabama at Huntsville), *On Intersections of Independent Space-Time Anisotropic Gaussian Fields* (p. 243)
17:00 - 17:30	Mike Kouritzin (University of Alberta), *Local interactions in stochastic differential equations* (p. 241)

Tuesday June 8	**mardi 8 juin**
12:30 - 13:00	Markus Riedle (King's University London), *Stochastic evolution equations driven by cylindrical stable noise* (p. 242)
13:00 - 13:30	Carl Mueller (University of Rochester), *A Small Ball Problem for the Random String* (p. 241)
13:30 - 14:00	Jian Song (Shandong University), *Scaling limit of a directed polymer among a Poisson field of independent walks* (p. 242)
14:00 - 14:30	Jianliang Zhai (University of Science and Technology of China), *Large and moderate deviation principles for McKean-Vlasov SDEs with jumps* (p. 243)
16:00 - 16:30	Xiaowen Zhou (Concordia University), *Boundary behaviors for continuous-state nonlinear branching processes* (p. 244)
16:30 - 17:00	Wei Sun (Concordia University), *Periodic solutions of hybrid jump diffusion processes* (p. 243)

Abstracts/Résumés

MIKE KOURITZIN, University of Alberta
[Monday June 7 / lundi 7 juin, 17:00]
Local interactions in stochastic differential equations

This talk with be based on joint work with Tom Kurtz and Jie Xiong.

An infinite system of real-valued stochastic differential equations for particle locations is considered. The particles exhibit local interactions through drift coefficients that depend upon other particles within a fixed distance. Strong existence and uniqueness is proved for this particle system with potentially discontinuous, local interactions. Current related work in stochastic partial differential equations will be discussed if time permits.

CARL MUELLER, University of Rochester
[Tuesday June 8 / mardi 8 juin, 13:00]
A Small Ball Problem for the Random String

This is joint work with Siva Athreya and Mathew Joseph.

Small ball problems for stochastic processes have a long history. One seeks to estimate the probability that a process stays in a small ball for a long time. Such estimates help us study the Hausdorff measure of the range of the process, among other things. Most such results involve Markov processes taking values in finite dimensional spaces, or Gaussian random fields. We establish a small ball estimate for vector-valued solutions of the stochastic heat equation with multiplicative white noise, which falls outside of the class of processes mentioned above. At one point we need to use the best constant in the Burkholder-Davis-Gundy inequality for large values of p.

DAVID NUALART
[Monday June 7 / lundi 7 juin, 12:30]
Convergence of densities for the stochastic heat equation

Consider the one-dimensional stochastic heat equation driven by a space-time white noise with constant initial condition. The purpose of this talk is to present a recent result on the uniform convergence of the density of the normalized spatial averages of the solution on an interval $[-R, R]$, as R tends to infinity, to the density of the standard normal distribution, assuming some non-degeneracy and regularity conditions on the nonlinear coefficient σ. The proof is based on the combination of the techniques of Malliavin calculus with Stein's method for normal approximations.

MARKUS RIEDLE, King's College London
[Tuesday June 8 / mardi 8 juin, 12:30]
Stochastic evolution equations driven by cylindrical stable noise

In this talk we present an existence result for the mild solution of a stochastic evolution equation driven by a symmetric α-stable cylindrical Lévy process defined on a Hilbert space for $\alpha \in (1, 2)$. In contrast to other literature, our work is based on the so-called semigroup approach to SPDEs. Similar to the fact that there are no standard Gaussian distribution in an infinite dimensional Hilbert space, the symmetric α-stable noise only exists in a generalised sense. As a consequence, to derive the existence result, we need to employ some non-standard methods, which we will present and discuss in this talk.

Joint work with Tomasz Kosmala.

MICKEY SALINS, Boston University
[Monday June 7 / lundi 7 juin, 13:30]
Global solutions for the stochastic reaction-diffusion equation with polynomially dissipative forcing

We identify a condition that implies that solutions to the stochastic reaction-diffusion equation $\frac{\partial u}{\partial t} = \mathcal{A}u + f(u) + \sigma(u)\dot{W}$ on a bounded spatial domain never blow up. We consider the case where f features polynomial dissipativity of the form $f(u)\text{sign}(u) \leq \breve{} K_1|u|^\beta$ for $\beta > 1$ and $|u|$ large. This kind of strong dissipation prevents solutions from blowing up even when the multiplicative noise coefficient grows polynomially like $|\sigma(u)| \leq K_2(1 + |u|^\gamma)$ as long as $\gamma < 1 + \frac{(1-\eta)(\beta-1)}{2}$. The constant $\eta \in (0, 1)$ is a scalar that describes a relationship between the eigenvalues of the of linear operator and the eigenvalues of the Gaussian noise.

JIAN SONG, Shandong University
[Tuesday June 8 / mardi 8 juin, 13:30]
Scaling limit of a directed polymer among a Poisson field of independent walks

This talk is based on a joint work with Hao Shen, Rongfeng Sun and Lihu Xu.

We consider a directed polymer model in dimension $1 + 1$, where the disorder is given by the occupation field of a Poisson system of independent random walks on $\mathbb{Z}$. In a suitable continuum and weak disorder limit, we show that the family of quenched partition functions of the directed polymer converges to the Stratonovich solution of a multiplicative stochastic heat equation (SHE) with a Gaussian noise, whose space-time covariance is given by the heat kernel.

In contrast to the case with space-time white noise where the solution of the SHE admits a Wiener-Itô chaos expansion, we establish an L^1-convergent chaos expansions of iterated integrals generated by Picard iterations. Using this expansion and its discrete counterpart for the polymer partition functions, the convergence of the terms in the expansion is proved via functional analytic arguments and heat kernel estimates. The Poisson random walk system is amenable to careful moment analysis, which is an important input to our arguments.

XIAOMING SONG, Drexel University
[Monday June 7 / lundi 7 juin, 13:00]
Spatial averages for the Parabolic Anderson model driven by rough noise

In this paper, we study spatial averages for the parabolic Anderson model in the Skorohod sense driven by rough Gaussian noise, which is colored in space and time. We include the case of a fractional noise with Hurst parameters H_0 in time and H_1 in space, satisfying $H_0 \in (1/2, 1)$, $H_1 \in (0, 1/2)$ and $H_0 + H_1 > 3/4$. Our main result is a functional central limit theorem for the spatial averages. As an important ingredient of our analysis, we present a Feynman-Kac formula that is new for these values of the Hurst parameters.

WEI SUN, Concordia University
[Tuesday June 8 / mardi 8 juin, 16:30]
Periodic solutions of hybrid jump diffusion processes

We investigate periodic solutions of regime-switching jump diffusions. Uniqueness of periodic solutions to the corresponding SDEs or SPDEs is obtained by the strong Feller property and irreducibility of the associated time-inhomogeneous semigroups. Concrete examples are presented to illustrate the results. This talk is based on joint work with Xiao-Xia Guo and Chun Ho Lau.

DONGSHENG WU, University of Alabama in Huntsville
[Monday June 7 / lundi 7 juin, 16:30]
On Intersections of Independent Space-Time Anisotropic Gaussian Fields

Let $X^H = \{X^H(s), s \in \mathbb{R}^{N_1}\}$ and $X^K = \{X^K(t), t \in \mathbb{R}^{N_2}\}$ be two independent centered space-time anisotropic Gaussian random fields taking values in $\mathbb{R}^d$. In this talk, we study the existence of intersections of X^H and X^K. Furthermore, we determine the Hausdorff dimensions of the set of intersection times and the set of intersection points of the random fields, respectively.

This talk is based on a joint work with Zhenlong Chen and Jun Wang.

YIMIN XIAO, Michigan State University
[Monday June 7 / lundi 7 juin, 16:00]
Regularity Properties and Propagation of Singularities of the Stochastic Wave Equation

This talk is concerned with the regularity properties of the solution of the stochastic wave equation with additive Gaussian noise which is white in time and homogeneous in space. We show that the solution $\{u(t, x), t \geq 0, x \in \mathbb{R}\}$, as a Gaussian random field, has the property of sectorial local nondeterminism. Based on this property, we establish the exact uniform modulus of continuity for the solution.

We also study the problem of "propagation of singularities" for the solution $\{u(t, x), t \geq 0, x \in \mathbb{R}\}$. Our approach is based on a simultaneous law of the iterated logarithm and general methods for Gaussian processes.

This talk is based on joint papers with Cheuk-Yin Lee.

JIANLIANG ZHAI, University of Science and Technology of China
[Tuesday June 8 / mardi 8 juin, 14:00]
Large and moderate deviation principles for McKean-Vlasov SDEs with jumps

We consider McKean-Vlasov stochastic differential equations (MVSDEs) driven by Lévy noise. By identifying the right equations satisfied by the solutions of the MVSDEs with shifted driving Lévy noise, we build up a framework to fully apply the weak convergence method to establish large and moderate deviation principles for MVSDEs. In the case of ordinary SDEs, the rate function is calculated by using the solutions of the corresponding skeleton equations simply replacing the noise by the elements of the Cameron-Martin space. It turns out that the correct rate function for MVSDEs is defined through the solutions of skeleton equations replacing the noise by smooth functions and replacing the distributions involved in the equation by the distribution of the solution of the corresponding deterministic equation (without the noise). This is somehow surprising. With this approach, we obtain large and moderate deviation principles for much wider classes of MVSDEs in comparison with the existing literature (see AAP 29(2019),1487-1540). This talk is based on joint work with Wei Liu, Yulin Song, and Tusheng Zhang.

XIAOWEN ZHOU, Concordia University
[Tuesday June 8 / mardi 8 juin, 16:00]
Boundary behaviors for continuous-state nonlinear branching processes

We consider a class of continuous-state branching processes with nonadditive branching mechanism. Such a process arises as nonnegative solution to a generalized version of the stochastic differential equation (driven by both a Brownian motion and a spectrally positive Poisson random measure) for the classical continuous-state branching process. We present quite sharp conditions on parameters of the SDE under which extinction, explosion or coming down from infinity occurs, respectively, to these processes.

The talk is based on joint work with Pei-Sen Li and Xu Yang.

Symplectic geometry
Géométrie symplectique

Org: Lisa Jeffrey (Toronto), **Derek Krepski** (Manitoba) and/et **Luke Volk** (Ottawa)

Schedule/Horaire

Wednesday June 9	**mercredi 9 juin**
13:00 - 13:30	Brent Pym (McGill University), *A local Torelli theorem for log symplectic manifolds* (p. 247)
13:30 - 14:00	Mykola Matviichuk (McGill University), *Forty families of log symplectic forms on CP^4* (p. 247)
14:00 - 14:30	Jacques Hurtubuise (McGill University), *Torsors over the moduli of bundles* (p. 246)
16:00 - 16:30	Reyer Sjamaar (Cornell University), *Toric symplectic stacks* (p. 248)
16:30 - 17:00	Peter Crooks (Northeastern University), *Hamiltonian reduction along a pre-Poisson subvariety* (p. 245)

Thursday June 10	**jeudi 10 juin**
13:00 - 13:30	Eckhard Meinrenken (University of Toronto), *On the Virasoro coadjoint action* (p. 247)
13:30 - 14:00	Yiannis Loizides (Cornell University), *Hamiltonian loop group spaces and a theorem of Teleman and Woodward* (p. 246)
14:00 - 14:30	Peter Kristel (University of Manitoba), *The smooth spinor bundle on loop space* (p. 246)
16:00 - 16:30	Megumi Harada (McMaster University), *A local normal form for Hamiltonian Poisson-Lie group actions* (p. 245)
16:30 - 17:00	Steven Rayan (Saskatchewan), *Integrability and symplectic duality for generalized hyperpolygons* (p. 247)
17:00 - 17:30	Jeremy Lane (McMaster University), *Cohomology of Gelfand-Zeitlin fibers* (p. 246)

Abstracts/Résumés

PETER CROOKS, Northeastern University
[Wednesday June 9 / mercredi 9 juin, 16:30]
Hamiltonian reduction along a pre-Poisson subvariety

Topological quantum field theories (TQFTs) serve to inspire many important constructions in geometry and representation theory. A concrete example of this inspiration comes from a paper of Moore and Tachikawa, where the authors conjecture the existence of a certain TQFT taking values in holomorphic symplectic varieties. Verifying this conjecture amounts to constructing a particular family of holomorphic symplectic varieties indexed by the natural numbers, the so-called *Moore–Tachikawa varieties*. Ginzburg and Kazhdan thereby prove Moore and Tachikawa's conjecture.

I will realize the Ginzburg–Kazhdan construction as an instance of "Hamiltonian reduction along a pre-Poisson subvariety", a procedure developed jointly with Maxence Mayrand. This reduction procedure also encompasses Marsden–Weinstein reduction, symplectic implosion, Mikami–Weinstein reduction, and hyperkähler slices, all of which I will explain if time permits.

This represents joint work with Maxence Mayrand.

MEGUMI HARADA, McMaster University
[Thursday June 10 / jeudi 10 juin, 16:00]
A local normal form for Hamiltonian Poisson-Lie group actions

We present a local normal form for Hamiltonian actions of Poisson-Lie groups K on a symplectic manifold equipped with a K^*-valued moment map, where K^* is a dual Poisson-Lie group to K. Our proof uses the delinearization theorem of Alexeev,

Meinrenken, and Woodward, which relates a classical Hamiltonian action of K with $\mathfrak{k}^*$-valued moment map to a Hamiltonian action with a K^*-valued moment map, via a deformation ("delinearization") of symplectic structures. We obtain our main result by proving a "delinearization commutes with symplectic reduction" theorem which is also of independent interest, and then putting this together with the local normal form theorem for classical Hamiltonian actions wtih $\mathfrak{k}^*$-valued moment maps. A key ingredient for our main result is the delinearization $\mathcal{D}(\omega_{can})$ of the canonical symplectic structure on T^*K. Time permitting, I will briefly describe some steps toward explicit computations of $\mathcal{D}(\omega_{can})$. This talk is based on joint work with an undergraduate, Mr. Aidan Patterson, and Jeremy Lane, for an NSERC summer USRA project.

JACQUES HURTUBUISE, McGill University
[Wednesday June 9 / mercredi 9 juin, 14:00]
Torsors over the moduli of bundles

If M is the moduli space of bundles over a Riemann surface X, then we can define two torsors for T^*M: - the first is the moduli C of pairs (bundles, flat connections) ; -the second involves taking the determinant line bundle L over M, and considering on L, the bundle $Conn$ of connections (the thing of which a section would be a connection on L). Curiously the two (C and $Conn$) are equivalent as torsors, and even symplectomorphic. The identifications go by choosing a pair of canonical and seemingly unrelated sections over M ; we do this in two ways. The identification seems to be fairly robust, as it is independent of which pair is chosen.

A similar picture holds over the bigger space of pairs (curve, bundle on that curve), that is, allowing the curve to move.

(joint work with Indranil Biswas, and Volodya Rubtsov)

PETER KRISTEL, University of Manitoba
[Thursday June 10 / jeudi 10 juin, 14:00]
The smooth spinor bundle on loop space

Given a smooth manifold, M, there is a hierarchy of interesting extra structures that M may or may not admit: $\mathrm{metric} \leftarrow \mathrm{orientation} \leftarrow \mathrm{spin\ structure} \leftarrow \mathrm{string\ structure} \leftarrow \ldots$, these structures correspond to reductions of the structure group of TM along the Whitehead tower of the orthogonal group $\mathrm{GL}(d) \cong \mathrm{O}(d) \leftarrow \mathrm{SO}(d) \leftarrow \mathrm{Spin}(d) \leftarrow \mathrm{String}(d) \leftarrow \ldots$. Manifolds which admit a spin structure have extremely rich geometry, and are still being studied intensively. Manifolds with a string structure, on the other hand, are not nearly as well understood. One of the main difficulties is that $\mathrm{String}(d)$ is not a Lie group. In the eighties, Killingback argued that a string structure on M induces a spin structure on the smooth loop space $LM = C^\infty(S^1, M)$. Seemingly, this exchanges one difficulty for another, because LM is infinite dimensional, and classical spin geometry does not apply. In this talk I will explain how to adapt one of the fundamental notions of spin geometry, namely the spinor bundle, to this infinite dimensional case.

JEREMY LANE, McMaster University
[Thursday June 10 / jeudi 10 juin, 17:00]
Cohomology of Gelfand-Zeitlin fibers

Gelfand-Zeitlin systems are completely integrable systems on unitary and orthogonal coadjoint orbits that share many features with toric systems. One thing that distinguishes them from toric systems is the presence of moment map fibers which are not tori. As some of the non-toric Gelfand-Zeitlin fibers are Lagrangian, they may play an important role in the geometric quantization and Fukaya category of unitary and orthogonal coadjoint orbits. This motivates a better understanding of the topology of these fibers. In this talk I will present recent work with Jeffrey Carlson in which we computed the cohomology of the non-toric fibers in terms of the combinatorics of the associated Gelfand-Zeitlin polytopes.

YIANNIS LOIZIDES, Cornell University
[Thursday June 10 / jeudi 10 juin, 13:30]
Hamiltonian loop group spaces and a theorem of Teleman and Woodward

I will revisit a theorem of Teleman and Woodward that computes the index of the Atiyah-Bott K-theory classes on the moduli space of G-bundles on a curve. I will describe a perspective on this theorem that is based on Hamiltonian loop group spaces, symplectic geometry, and index theory.

MYKOLA MATVIICHUK, McGill University
[Wednesday June 9 / mercredi 9 juin, 13:30]
Forty families of log symplectic forms on CP^4

I will explain how the local Torelli theorem from Brent Pym's talk describes (not necessarily toric) deformations of toric log symplectic forms on complex projective spaces. I will introduce smoothing diagrams, which are certain graphs with decorations that encode such deformations, discuss combinatorial rules that govern them, and present a complete classification of smoothing diagrams for the case of CP^4. The obtained list of 40 smoothing diagrams amounts to 40 families of log symplectic forms on CP^4, most of which are new. Time permitting, I will discuss how to read off geometric properties of the obtained log symplectic forms from the smoothing diagrams. This is joint work with Brent Pym and Travis Schedler.

ECKHARD MEINRENKEN, University of Toronto
[Thursday June 10 / jeudi 10 juin, 13:00]
On the Virasoro coadjoint action

The Virasoro algebra $\mathfrak{vir}$ is the non-trivial central extension of the Lie algebra of vector fields on the circle. There is a well-known 1-1 correspondence between the coadjoint orbits in the level 1 subspace $\mathfrak{vir}_1^* \subset \mathfrak{vir}^*$ and conjugacy classes in a certain open subset $U \subset \widetilde{\mathrm{SL}}(2,R)$. We extend this correspondence by taking into account the geometric structure, giving a Morita equivalence between the Poisson structure on $\mathfrak{vir}_1^*$ and the Cartan-Dirac structure on U. (Joint work with Anton Alekseev.)

BRENT PYM, McGill University
[Wednesday June 9 / mercredi 9 juin, 13:00]
A local Torelli theorem for log symplectic manifolds

A log symplectic manifold is a holomorphic symplectic manifold whose two-form is allowed to have logarithmic poles on a hypersurface. I will describe the structure of the moduli space of such manifolds near the locus of log symplectic manifolds whose divisor has normal crossings. Generically, the moduli space is smooth and parameterized by the periods of the two-form, in parallel with the classical local Torelli theorems for compact hyperkähler manifolds. However, when the periods satisfy certain integer-linear conditions, we find new irreducible components of the moduli space corresponding to structures where the normal crossings divisor is deformed to a more interesting singularity type (e.g. elliptic). This talk is based on joint work with Mykola Matviichuk and Travis Schedler, and is a prequel to Matviichuk's talk, which will explain how these techniques can be used to obtain nontrivial global classification results, using projective spaces as an example.

STEVEN RAYAN, University of Saskatchewan
[Thursday June 10 / jeudi 10 juin, 16:30]
Integrability and symplectic duality for generalized hyperpolygons

In this talk, I will construct a generalization of hyperpolygon space from a comet-shaped quiver. The resulting Nakajima quiver variety can be interpreted as a distinguished subvariety of a moduli space of meromorphic Higgs bundles on a punctured curve.

I will discuss how this space of generalized hyperpolygons inherits, for complete and minimal flags, a Gelfand-Tsetlin-type integrable system from the reduction of a product of cotangent bundles of (partial) flag varieties, as shown in joint work with Laura Schaposnik. Inspired by this work, I will introduce a conjectural Coulomb branch for the space of generalized hyperpolygons, which is one step towards fully realizing symplectic duality in this setting.

REYER SJAMAAR, Cornell University
[Wednesday June 9 / mercredi 9 juin, 16:00]
Toric symplectic stacks

I will outline B. Hoffman's theory of toric symplectic stacks, which are classified by simple, not necessarily rational, convex polytopes equipped with some additional combinatorial data. The orbit space of a toric symplectic stack is a toric symplectic quasifold in the sense of Prato. Hoffman's results extend Delzant's classification of compact toric symplectic manifolds. His theory is distinct from the theory of toric stacks developed by algebraic geometers.

The early Langlands Program and Number Theory
Les débuts du programme Langlands et la théorie des nombres

Org: Julia Mueller (Fordham University)

Schedule/Horaire

Monday June 7	**lundi 7 juin**
13:00 - 14:00	Matthew Emerton (University of Chicago), *The Langlands program: past, present, and future* (p. 249)

Friday June 11	**vendredi 11 juin**
13:00 - 14:00	Freydoon Shahidi (Purdue University), *Langlands' Automorphic L-functions and Functoriality Principle* (p. 249)

Abstracts/Résumés

MATTHEW EMERTON, University of Chicago
[Monday June 7 / lundi 7 juin, 13:00]
The Langlands program: past, present, and future

In this talk I will discuss the functoriality and reciprocity conjectures of Langlands, which are the central focus of the Langlands program. I will begin with a historical overview of the theory of reciprocity laws in number theory, and then explain Langlands's very general reciprocity conjecture. This conjecture itself suggests another conjecture, purely within the theory of automorphic forms: the functoriality conjecture. (The historical order of the discovery of these conjectures was in the opposite order, with the functoriality conjecture being formulated first, in Langlands' famous letter to Weil.) In fact, as Langlands already observed, functoriality, formulated in a suitably broad fashion, can to a certain extent incorporate reciprocity within its framework. In any case, the two problems are closely related. I will close the talk by describing some examples of recent progress (by various authors) on both conjectures.

FREYDOON SHAHIDI, Purdue University
[Friday June 11 / vendredi 11 juin, 13:00]
Langlands' Automorphic L-functions and Functoriality Principle

This expository talk is an appreciation of some of the Langlands's early work which may be considered as the starting point of his program. I will discuss how his work on the Eisenstein series and his computations of their constant terms led him to define a number of important notions within his program: L-groups, Frobenius-Hecke conjugacy classes, and consequently L-functions, an object which he had been searching for quite sometime unsuccessfully, before he did these calculations. These objects, discovered in the second half of 1966, also played an important role in his famous 1967 letter to Andre Weil. The same ingredients were essential in the formulation of his Functoriality Principle which we will report on during this talk as well.

Transitioning to University: Indigenous Perspectives on Post-Secondary Mathematics
La transition vers l'université : Perspectives autochtones sur les mathématiques postsecondaires

Org: **Darja Barr** (Manitoba), **Benoit Dionne** (Ottawa) and/et **Emily McKinnon** (Manitoba)

Schedule/Horaire

Tuesday June 8	**mardi 8 juin**
16:00 - 16:30	Wanbdi Wakita (University of Manitoba) (p. 252)
16:30 - 17:00	Michelle Hogue (University of Lethbridge), *Indigenous Student Success Cohort Program: A Path to Enabling Indigenous Student Academic Success* (p. 251)
17:00 - 17:30	Samar Safi-Harb (University of Manitoba), *Transitioning to University Life in Pursuit of Science: Barriers and Pathways to Indigenous Achievement* (p. 252)
17:30 - 18:00	Shawn Desaulniers (University of Alberta), *Indigenization of Mathematics Courses for Teaching Candidates* (p. 250)

Thursday June 10	**jeudi 10 juin**
12:30 - 13:00	Gordon Naylor (Maskwacîs Education Schools Commission), *Indigenous Students and High School Mathematics* (p. 252)
13:00 - 13:30	Melania Alvarez (PIMS), *Addressing Mathematical Inequity in Indigenous Education:* (p. 250)
13:30 - 14:00	Ed Doolittle (University of Regina) (p. 251)
14:00 - 14:30	Diana Klassen (University of Manitoba), *Mathematics in an Indigenous Engineering Program* (p. 251)
16:00 - 16:30	Veselin Jungic & Antonieta Mar-y-paz Rivera (Simon-Fraser University), *SFU Indigenous University Preparation Program: Past, Present, and Future* (p. 251)
16:30 - 18:00	Victoria McIntosh (University of Manitoba) (p. 251)

Friday June 11	**vendredi 11 juin**
12:30 - 14:00	Anderson-Sackaney, Naylor, Klassen, Doolittle, Wanbdi (p. 252)

Abstracts/Résumés

MELANIA ALVAREZ, UBC Department of Mathematics/PIMS
[Thursday June 10 / jeudi 10 juin, 13:00]
Addressing Mathematical Inequity in Indigenous Education:

In order to positively narrow the educational gap between the Indigenous communities and the rest of the population, there needs to be a continuous and long-term intervention for change. In the case of schooling, we should be working with the Indigenous communities to look at a long-term continuum of choices and to present opportunities and positive interventions that provide students with a more affirmative outlook for life. The Pacific Institute for the Mathematical Sciences (PIMS) has recognized the challenges many students face if they lack the necessary prerequisites in math and science to pursue post-secondary studies (especially in STEM fields), specifically when it comes to Indigenous students and other students at risk. By leaving behind the philosophy of reduced expectations, mathematical scientists and educators associated with PIMS have introduced a variety of interesting and challenging programs. Our first step has been to build partnerships with elders and schools run by Indigenous communities, as well as with urban public schools with a high concentration of at-risk students. With their input and support, the PIMS outreach team has implemented a variety of programs, which will be described on this talk.

Transitioning to University: Indigenous Perspectives on Post-Secondary Mathematics
La transition vers l'université : Perspectives autochtones sur les mathématiques postsecondaires

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SHAWN DESAULNIERS, University of Alberta
[Tuesday June 8 / mardi 8 juin, 17:30]
Indigenization of Mathematics Courses for Teaching Candidates

In this presentation, I will discuss a collaborative effort with the University of Alberta's Aboriginal Teacher Education Program (ATEP) to improve the math content knowledge of their teaching candidates.

ED DOOLITTLE, University of Regina
[Thursday June 10 / jeudi 10 juin, 13:30]

MICHELLE HOGUE, University of Lethbridge
[Tuesday June 8 / mardi 8 juin, 16:30]
Indigenous Student Success Cohort Program: A Path to Enabling Indigenous Student Academic Success

Traditionally, Indigenous ways of knowing and learning (IWKL) are relational, hands-on, and practical and knowledge is passed on orally through story, language, ceremony, and traditional practice. This way of learning often creates a challenge for Indigenous learners in the traditional Euro-Western system of compartmentalized, theory-first and written methodological approaches to teaching and learning. Nowhere is this truer than in the sciences and mathematics.

The Indigenous Student Success Cohort (ISSC) program at the University of Lethbridge (UofL) in Alberta, Canada is a well-recognized, successful first-year program that provides a solid academic foundation and skill set to enable Indigenous students to succeed in their degree of choice. Key to the success of the ISSC, is the bridging of Indigenous and Western cultures, the creation of community, a culturally relevant, highly interactive, learning, and supportive environment, and attention to Indigenous Ways of Knowing and Learning (IWKL). Our statistics show that Indigenous students who enter university through this program are retained to graduation at a 10

This presentation will be a sharing of our journey the ups and downs, and lessons learned.

VESELIN JUNGIC & ANTONIETA MAR-Y-PAZ RIVERA, Simon Fraser University
[Thursday June 10 / jeudi 10 juin, 16:00]
SFU Indigenous University Preparation Program: Past, Present, and Future

Since 2007 the SFU Indigenous University Preparation Program has been welcoming First Nations, Métis and Inuit students to a university learning environment that affirms and integrates Indigenous knowledge and perspectives.

In this presentation we will briefly describe the program and list its main goals. We will also, discuss some of the past and present successes and challenges that students, instructors, and administrators involved in the program have experienced.

DIANA KLASSEN, University of Manitoba
[Thursday June 10 / jeudi 10 juin, 14:00]
Mathematics in an Indigenous Engineering Program

This session will introduce you to the Engineering Access Program (ENGAP) at the University of Manitoba. ENGAP provides academic and personal supports to First Nations, Non-status, Metis and Inuit students. Since mathematics forms an integral part of engineering studies, weaknesses in grade school and high school mathematics are examined, and solutions implemented by ENGAP will be shared.

Transitioning to University: Indigenous Perspectives on Post-Secondary Mathematics
La transition vers l'université : Perspectives autochtones sur les mathématiques postsecondaires

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VICTORIA MCINTOSH, University of Manitoba
[Thursday June 10 / jeudi 10 juin, 16:30]

GORDON NAYLOR, Maskwacis Education Schools Commission
[Thursday June 10 / jeudi 10 juin, 12:30]
Indigenous Students and High School Mathematics

Tansi kahkiyaw, kitatamiskatinawaw (Hello everyone, I greet you all).

I am a proud member of the Muskoday First Nation and have been a math teacher in reserve schools for the past 8 years. I currently teach in Neyaskweyahk (Ermineskin Cree Nation, in Maskwacis, Alberta). I look to share some of my experiences and find out how to improve my practice to help give my students the best chance at accomplishing their dreams.

This presentation will look at historical and contemporary issues affecting Indigenous People's and western education, particularly issues surrounding mathematics education.

SAMAR SAFI-HARB, University of Manitoba
[Tuesday June 8 / mardi 8 juin, 17:00]
Transitioning to University Life in Pursuit of Science: Barriers and Pathways to Indigenous Achievement

Indigenous peoples are severely under-represented in STEM and this under-representation gets more enhanced as we go up the ladder in education. In this talk, I will highlight some of the barriers encountered by Indigenous students in Science education, and particularly in the Mathematical and Physical Sciences. I will then describe recent efforts led at the University of Manitoba (UofM) and in the Faculty of Science committed to creating pathways to Indigenous achievement. In particular, I highlight 'Wawatay', a new initiative in Science aimed at creating a supportive (academic, research, social and personal) path for Indigenous students in pursuit of a degree in Science at the UofM.

WANBDI WAKITA, University of Manitoba
[Tuesday June 8 / mardi 8 juin, 16:00]

ANDERSON-SACKANEY, NAYLOR, KLASSEN, DOOLITTLE, WANBDI,
[Friday June 11 / vendredi 11 juin, 12:30]

Variational Analysis: Theory and Applications
Analyse Variationnelle : Théorie et Applications

Org: Heinz Bauschke and/et **Xianfu Wang** (UBC Okanagan)

Schedule/Horaire

Wednesday June 9 — **mercredi 9 juin**

12:30 - 13:00	Jim Zhu (Western Michigan), *Bank Balance Sheet Risk Allocation with Linear Programming* (p. 256)
13:00 - 13:30	Walaa Moursi (Waterloo), *Further notions of monotonicity and corresponding properties of resolvents and reflected resolvents* (p. 253)
13:30 - 14:00	Hui Ouyang (UBC Okanagan), *Bregman Circumcenters* (p. 254)
14:00 - 14:30	Sedi Bartz (UMass Lowell), *Monotone operators and convex analysis in multi-marginal settings* (p. 253)
16:00 - 17:00	Hristo Sendov (Western), *A unified approach to operator monotone functions* (p. 254)

Thursday June 10 — **jeudi 10 juin**

12:30 - 13:00	Jane Ye (Victoria), *Difference of convex algorithms for bilevel programs with applications in hyperparameter selection* (p. 255)
13:00 - 13:30	Yao-Liang Yu (Waterloo), *An Operator Splitting View of Federated Learning* (p. 255)
13:30 - 14:00	Hung Phan (UMass Lowell), *Adaptive Splitting Algorithms* (p. 254)
14:00 - 14:30	Ziyuan Wang (UBC Okanagan), *Calculus rules of the generalized Kurdyka-Łojasiewicz property* (p. 255)
16:00 - 16:30	Shambhavi Singh (UBC Okanagan), *Finding Best Approximation Pairs for Two Intersections of Closed Convex Sets* (p. 255)
16:30 - 17:00	Heinz Bauschke (UBC Okanagan), *Compositions of projection mappings: fixed point sets and difference vectors* (p. 253)
17:00 - 17:30	Xianfu Wang (UBC Okanagan), *Attouch-Thera Duality, Generalized Cycles and Gap Vectors* (p. 255)

Abstracts/Résumés

SEDI BARTZ, University of Massachusetts Lowell
[Wednesday June 9 / mercredi 9 juin, 14:00]
Monotone operators and convex analysis in multi-marginal settings

Motivated by multi-marginal optimal transport, we discuss aspects of its underlying monotone and convex analytic structure. We review recent extensions of classical maximal monotonicity and convex analysis into multi-marginal settings. We point out several open questions as well as partial resolutions and examples. In particular, we focus on an extension of Minty's characterization of maximal monotonicity and a generalization of the maximal monotonicity of the convex subdifferential.

HEINZ BAUSCHKE, UBC Okanagan
[Thursday June 10 / jeudi 10 juin, 16:30]
Compositions of projection mappings: fixed point sets and difference vectors

Projection operators and associated projection algorithms are fundamental building blocks in fixed point theory and optimization.

In this talk, I will survey recent results on the displacement mapping of the right-shift operator and sketch a new application deepening our understanding of the geometry of the fixed point set of the composition of projection operators in Hilbert space.

Based on joint works with Salha Alwadani, Julian Revalski, and Shawn Wang.

WALAA MOURSI, University of Waterloo
[Wednesday June 9 / mercredi 9 juin, 13:00]
Further notions of monotonicity and corresponding properties of resolvents and reflected resolvents

The correspondence between the monotonicity of a (possibly) set-valued operator and the firm nonexpansiveness of its resolvent is a key ingredient in the convergence analysis of many optimization algorithms. Firmly nonexpansive operators form a proper subclass of the more general - but still pleasant from an algorithmic perspective - class of averaged operators. In this talk, we introduce the notion of conically nonexpansive operators which generalize nonexpansive mappings. We characterize averaged operators as being resolvents of comonotone operators under appropriate scaling. As a consequence, we characterize the proximal point mappings associated with hypoconvex functions as cocoercive operators, or equivalently ; as displacement mappings of conically nonexpansive operators. Several examples illustrate our analysis and demonstrate the tightness of our results.

HUI OUYANG, University of British Columbia, Okanagan
[Wednesday June 9 / mercredi 9 juin, 13:30]
Bregman Circumcenters

In this talk, we first characterize backward and forward Bregman projections onto affine subspaces. Then we introduce backward and forward Bregman (pseudo-)circumcenter operators associated with finite sets. We also demonstrate the existence of backward and forward Bregman (pseudo-)circumcenters of finite sets and show explicit formulae for the unique backward and forward Bregman pseudo-circumcenters of finite sets. Moreover, we state some dual expressions of the backward and forward Bregman (pseudo-)circumcenters of finite sets. Various examples are presented to illustrate the backward and forward Bregman (pseudo-)circumcenters of finite sets. In particular, one example illuminates the existence of the backward Bregman pseudo-circumcenter, while the traditional circumcenter under the Euclidean distance does not exists.

HUNG PHAN, University of Massachusetts Lowell
[Thursday June 10 / jeudi 10 juin, 13:30]
Adaptive Splitting Algorithms

A general optimization problem can often be reduced to finding a zero of a sum of multiple (maximally) monotone operators, which creates challenging computational tasks as a whole. It motivates the development of splitting algorithms in order to simplify the computations by dealing with each operator separately. Some of the most successful splitting algorithms in applications are the forward-backward algorithm, the Douglas-Rachford algorithm, and the alternating directions method of multipliers (ADMM). In this talk, we discuss some adaptive generalizations of such splitting algorithms. The main idea is to adapt the algorithm parameters to the properties of each operators so that the generated sequences converge to a fixed point.

HRISTO SENDOV, The University of Western Ontario
[Wednesday June 9 / mercredi 9 juin, 16:00]
A unified approach to operator monotone functions

The notion of operator monotonicity dates back to a work by Löwner in 1934. A map $F : S^n \to S^m$ is called *operator monotone*, if $A \succeq B$ implies $F(A) \succeq F(B)$. (Here, S^n is the space of symmetric matrices with the semidefinite partial order $\succeq$.) Often, the function F is defined in terms of an underlying simpler function f. Of main interest is to find the properties of f that characterize operator monotonicity of F. In that case, it is said that f is also operator monotone. Classical examples are the Löwner operators and the spectral (scalar-valued isotropic) functions. Operator monotonicity for these two classes of functions is characterized in seemingly very different ways.

This talk extends the notion of operator monotonicity to symmetric functions f on k arguments. The latter is used to define *(generated) k-isotropic maps* $F : S^n \to S^{\binom{n}{k}}$ for any $n \geq k$. Necessary and sufficient conditions are given for f to generate

an operator monotone k-isotropic map F. When $k = 1$, the k-isotropic map becomes a Löwner operator and when $k = n$ it becomes a spectral function. This allows us to reconcile and explain the differences between the conditions for monotonicity for the Löwner operators and the spectral functions.

SHAMBHAVI SINGH, UBC Okanagan
[Thursday June 10 / jeudi 10 juin, 16:00]
Finding Best Approximation Pairs for Two Intersections of Closed Convex Sets

The problem of finding a best approximation pair of two sets, which in turn generalizes the well known convex feasibility problem, has a long history that dates back to work by Cheney and Goldstein in 1959.

In 2018, Aharoni, Censor, and Jiang revisited this problem and proposed an algorithm that can be used when the two sets are finite intersections of halfspaces. Motivated by their work, we present alternative algorithms that utilize projection and proximity operators. Numerical experiments indicate that these methods are competitive and sometimes superior to the one proposed by Aharoni et al.

XIANFU WANG, University of British Columbia
[Thursday June 10 / jeudi 10 juin, 17:00]
Attouch-Thera Duality, Generalized Cycles and Gap Vectors

Using the Attouch-Thera duality, we study the cycles, gap vectors and fixed point sets of compositions of proximal mappings. A primal-dual framework provides an exact relationship between the cycles and gap vectors. We also introduce the generalized cycle and gap vectors to tackle the case when the classical ones do not exist. Joint work with Bauschke and Alwadani.

ZIYUAN WANG, UBC Okanagan
[Thursday June 10 / jeudi 10 juin, 14:00]
Calculus rules of the generalized Kurdyka-Łojasiewicz property

In this work, we propose several calculus rules for the generalized Kurdyka-Łojasiewicz (KL) property, some of which generalize Li and Pong's results. We have shown in a parallel paper that the optimal desingularizing function has various forms and may be nondifferentiable. Our calculus rules do not assume desingularizing functions to have any specific form or differentiable, while the known results do. Several examples are also given to show that our calculus rules are applicable to a broader class of functions than the known ones.

JANE YE, University of Victoria
[Thursday June 10 / jeudi 10 juin, 12:30]
Difference of convex algorithms for bilevel programs with applications in hyperparameter selection

In this paper, we present difference of convex algorithms for solving bilevel programs in which the upper level objective functions are difference of convex functions, and the lower level programs are fully convex. This nontrivial class of bilevel programs provides a powerful modelling framework for dealing with applications arising from hyperparameter selection in machine learning. Thanks to the full convexity of the lower level program, the value function of the lower level program turns out to be convex and hence the bilevel program can be reformulated as a difference of convex bilevel program. We propose two algorithms for solving the reformulated difference of convex program and show their convergence under very mild assumptions. Finally we conduct numerical experiments to a bilevel model of support vector machine classification.

YAO-LIANG YU, University of Waterloo
[Thursday June 10 / jeudi 10 juin, 13:00]
An Operator Splitting View of Federated Learning

Federated learning (FL) has recently emerged as a massively distributed framework that enables training a shared or personalized model without infringing user privacy. In this work, we show that many of the existing FL algorithms can be understood from an operator splitting point of view. This unification allows us to compare different algorithms with ease, to refine previous convergence results and to uncover new algorithmic variants. In particular, our analysis reveals the vital role played by the step size in FL algorithms. The unification also leads to a streamlined and economic way to accelerate FL algorithms, without incurring any communication overhead. We perform numerical experiments on both convex and nonconvex models to validate our findings.

JIM ZHU, Western Michigan University
[Wednesday June 9 / mercredi 9 juin, 12:30]
Bank Balance Sheet Risk Allocation with Linear Programming

We discuss a bank balance sheet risk allocation problem arising in practical banking setting. This problem involves two different kinds of risks and, therefore, does not fit into the traditional portfolio model. We solve the problem with linear programming using duality. Both primal and dual solutions have intuitive financial explanations and provides insight for practical balance sheet management strategies. This is a joint work with Dr. Judice from Montepio Bank, Portugal.

AARMS-CMS Student Poster Session
Présentations par affiches des étudiants - AARMS-SMC

Org: Emily Carlson (University of Waterloo)

Abstracts/Résumés

STÉPHANIE ABO, University of Waterloo
[Thursday June 10 / jeudi 10 juin, 12:00]
Modeling the circadian regulation of the immune system: sexually dimorphic effects of shift work

Shift work has a negative impact on health and can lead to chronic diseases and illnesses. Under regular work schedules, rest is a night time activity and work a daytime activity. Shift work relies on irregular work schedules which disrupt the natural sleep-wake cycle. This can in turn disrupt our biological clock, called the circadian clock, a network of molecular interactions generating biochemical oscillations with a near 24-hour period. Clock genes regulate cytokines before and during infection and immune agents can also impact the clock function. We provide a mathematical model of the circadian clock in the rat lung coupled to an acute inflammation model to study how the disruptive effect of shift work manifests itself in males and females during inflammation. Our results show that the extent of sequelae experienced by male and female rats depends on the time of infection. The goal of this study is to provide a mechanistic insight of the dynamics involved in the interplay between these two systems.

DENIZ ASKIN, Carleton University
[Thursday June 10 / jeudi 10 juin, 12:00]
Coarse-To-Fine Semantic Parsing with Transformers

Semantic Parsing is the task of translating a natural language sentence to a language that can be processed by a computer (e.g. first-order-logic, lambda calculus and Prolog). This translation allows one, for example, to query databases and command virtual assistants using natural language. An example of a semantic parsing dataset is the Geo880, which contains 880 sentences in English on US geography, and their corresponding translations in Prolog format.

Ex: what is the population of oregon ? answer (A , (population (B , A) , const (B , stateid (oregon))))

Currently, neural network based models called Transformers (the engines behind Google's Translate) give state-of-the-art results on all of the benchmark sematic parsing datasets.

In this poster presentation, we will propose our own Transformer-Based Semantic Parser (TBSP) which uses a two-layered approach, each layer being a Transformer.

Our method uses a rough sketch of the parse (a 'coarse' parse) at the first layer, where the rough sketch contains an ordered list of all the logical operators, predicates, relations and constants present in the semantic parse of the inputted natural language sentence.

The second layer accepts this rough sketch as input and outputs the final semantic parse (a 'fine' parse).

We will be reporting on our model's performance on the Geo880 and its improvement over the accuracy of a one-layered TBSP.

HARRIS HAMID, McMaster University
[Thursday June 10 / jeudi 10 juin, 12:00]
Lebesgue Integration

This type of integration is modern and is another approach to integrating exotic functions. This method is a way to solve non-elementary functions such as the normal distribution function without error. It was invented by Henri Lebesgue, a French mathematician who noticed that the Riemann integral could not solve most of the non-elementary functions, so he introduced a newer approach to overcome the problems that the Riemann integral cannot solve.

YUYING LI, Western University
[Thursday June 10 / jeudi 10 juin, 12:00]
Modelling and pricing cyber security risk

The cyber risk insurance market is rapidly developing with more products being developed that cover the potential losses attributed to cyber attacks. This requires the insurance business to have a modelling and pricing framework necessary to obtain a fair price that will enable policy issuers to fulfill their future obligations. We present a valuation framework that integrates cyber risk modelling and calibration. A regime-switching Markov model is put forward to capture the occurrences of cyber attacks. The transition probabilities of the Markov chain are governed by another hidden Markov chain representing the various states of the cybersecurity environment. Based on the stages of the cyber attack, a cyber kill chain is built. The states are firewall working, firewall fail, and antiphising fail. A cyber attack happens when there is a transition from either of the first two states to the third state. With the aid of change of reference probability measures and the EM algorithm, dynamic estimates of the model parameters are obtained. Our main point of interest is the random loss from cyber attack, which is modelled by a doubly-truncated Pareto distribution. The Vasiček model is utilized to describe the interest rate process for the discounting of losses. The premium for a cyber security insurance contract is calculated via a simulated data set based on two pricing principles. Our methodology featuring dynamic parameter estimation and flexible adjustments in modelling various risk factors widens the available tools for valuation and risk management beneficial to insurance companies and regulators.

RAJARSHI MAITI, Queen's University Belfast
[Thursday June 10 / jeudi 10 juin, 12:00]

NICOLE MOON-KECA, Concordia University of Edmonton
[Thursday June 10 / jeudi 10 juin, 12:00]
An Application of the LLL Algorithm in Number Theory

The Mertens conjecture if proven to be true would imply one of the millennium problems, the Riemann Hypothesis. Odlyzko and te Riele disproved this conjecture by utilizing the Lenstra-Lenstra-Lovász algorithm (LLL). Moreover, the LLL algorithm can efficiently provide solutions for the problem of simultaneous Diophantine approximation. The purpose of this project is to study applications of the LLL algorithm, namely, Diophantine approximation and Mertens conjecture.

JAMES MORAN, University of Montreal
[Thursday June 10 / jeudi 10 juin, 12:00]
Non-linear ladder operators and coherent states for the 2:1 oscillator

The 2:1 two-dimensional anisotropic quantum harmonic oscillator is considered and new sets of states are defined by means of normal-ordering non-linear operators through the use of non-commutative binomial theorems as well as solving recurrence relations. The states generated are good candidates for the natural generalisation of the su(2) coherent states of the two-dimensional isotropic oscillator. The two-dimensional non-linear generalised ladder operators lead to several chains of states which are connected in a non trivial way. The uncertainty relations of the defining chain of states are calculated and it is found that they admit a resolution of the identity and the spatial distribution of the wavefunction produces Lissajous figures in correspondence with the classical 2:1 oscillator.

GAVIN OROK, University of Waterloo
[Thursday June 10 / jeudi 10 juin, 12:00]
Local Dimensions of Self-Similar Measures in the Sierpinski Gasket

This project attempted to determine the set of all possible local dimensions of points in the support of probability measures in the iterated function system (IFS) that generates the Sierpinski Gasket fractal. The Sierpinski Gasket is the generalization of the Sierpsinski's Triangle fractal to the case where the contraction factor of the IFS is in $(\frac{1}{2}, \frac{2}{3})$. Calculations of the fractal's Hausdorff dimension and the local dimensions of measures are challenging in this case because there are overlaps between the triangular images from the IFS. The method used in this project to overcome difficulties caused by these overlaps was based on work by Kathryn Hare, Kevin Hare and Kevin Matthews that studied the one-dimensional version of this problem, the Bernoulli convolutions. Like in this work, the analysis focused on multinacci number contraction factors that resulted in the measures used being of finite type. First, a system of finitely many characteristic vectors was constructed that partition the images from the IFS into sets with disjoint interior. Then, a system of transition matrices was derived that relate the measures of consecutive parents and children in admissible paths through the characteristic vectors. Products of these matrices were used in place of closed balls to simplify calculations of local dimensions. Finally, these simplified calculations were analyzed over possible paths of characteristic vectors and points in the support to determine bounds on the local dimensions. Overall, the research managed to find trends in heuristic upper and lower bounds on the set of local dimensions.

ELKIN RAMÍREZ, McMaster University
[Thursday June 10 / jeudi 10 juin, 12:00]
Singularity Formation in the Deterministic and Stochastic Fractional Burgers Equation.

Motivated by the results concerning the regularity of solutions to the fractional Navier-Stokes system and questions about the influence of noise on the formation of singularities in hydrodynamic models, we have explored these two problems in the context of the fractional 1D Burgers equation. First, we performed highly accurate numerical computations to characterize the dependence of the blow-up time on the fractional dissipation exponent in the supercritical regime. The problem was solved numerically using a pseudospectral method where integration in time was performed using a hybrid method combining the Crank-Nicolson and a three-step Runge-Kutta technique. A highlight of this approach is automated resolution refinement. The blow-up time was estimated based on the time evolution of the enstrophy (H^1 seminorm) and the width of the analyticity strip. The consistency of the obtained blow-up times was verified in the limiting cases. In the second part of the thesis we considered the fractional Burgers equation in the presence of suitably colored additive noise. This problem was solved using a stochastic Runge-Kutta method where the stochastic effects were approximated using a Monte-Carlo method. Statistic analysis of ensembles of stochastic solutions obtained for different noise magnitudes indicates that as the noise amplitude increases the distribution of blow-up times becomes non-Gaussian. In particular, while for increasing noise levels the mean blow-up time is reduced as compared to the deterministic case, solutions with increased existence time also become more likely.

TURNER SILVERTHORNE, University of Toronto
[Thursday June 10 / jeudi 10 juin, 12:00]
Promoter methylation in a mixed feedback loop circadian clock model

The circadian (about a day) clock strikes a balance between robust intrinsic rhythmicity and plasticity to environmental cues. At a cellular level, interconnected transcription-translation feedback loops produce reliable limit cycle oscillations in core clock proteins. Although there has been extensive mathematical modelling, important questions remain about the effects of environmental signals on the molecular circadian clock. For instance, recent experiments suggest that epigenetic factors play a role in stably altering the circadian period. Briefly, epigenetic factors encompass a variety of molecular modifications that convey heritable information without altering the DNA sequence. In this poster, we present and analyze a novel, minimal model of the circadian clock. By including an additional degree of freedom in the classical mixed feedback loop model of Francois and Hakim, we analyze how epigenetic regulation alters the dynamics of the clock. We obtain conditions for equilibrium uniqueness and an asymptotic approximation to the clock's period, which allow us to bound the influence of epigenetic factors in our model. We then use another set of approximations to connect our model to a modified version of the Goodwin oscillator, previously studied in this context by Kim and Forger. Analysis of this reduced model reveals that although epigenetic factors can alter the period, they may also result in a loss in rhythmicity. Our analysis adds a quantitative perspective to an active area of biological research and offers several avenues for future work.

AXEL G. R. TURNQUIST, New Jersey Institute of Technology
[Thursday June 10 / jeudi 10 juin, 12:00]

YOUNES VALIBEIGI, McGill University
[Thursday June 10 / jeudi 10 juin, 12:00]
Development of a closed-feedback loop device between graphics card simulations and cardiac tissue

Cardiovascular disease is number one cause of death worldwide. Tachycardias, which are potentially deadly rapid rhythms, are often associated with reentry. Reentry is either anatomical, where a wave rotates around an unexcitable obstacle, or functional, where the wave has a spiral or scroll morphology in the tissue. Methods for studying and generating strategies for abolishing reentrant waves are limited due to difficulties in dynamically responding to the wave in real-time. A hybrid computer tissue interface that controls cardiac tissue in real-time therefore has the potential to revolutionize approaches for treating arrhythmias. However, until recently the development of computational simulations that predict cardiac electrophysiological wave propagation required the use of dedicated workstations that typically took many minutes to simulate seconds of activity. With the aid of a newly developed computational library (Abubu.js) that harnesses the power of the graphics card, it is now possible to develop large-scale simulations that predict wave dynamics in real-time. Using these GPU based simulations, we built a closed feedback loop device that connects a cultured cardiac monolayer with 2D simulations in real-time. This device can control cardiac tissue through the use of optogenetic tools that sensitize the tissue to light. Motion detection cameras with the aid of appropriate algorithms read the monolayer activations and provide information to the simulation, which in turn stimulates the tissue using microcontrollers and LEDs. We plan to use our closed-feedback loop to investigate anatomical re-entrant waves and also aim to study the effect of neuronal input on anatomical waves.

STÉPHANE VINET, Université de Montréal
[Thursday June 10 / jeudi 10 juin, 12:00]
Excitations and ergodicity of critical quantum spin chains from non-equilibrium classical dynamics

We study a critical quantum spin-1/2 chain that is dual to the non-equilibrium Kawasaki dynamics of a classical Ising chain coupled to a bath. The quantum spin chain is stoquastic, and depends on a single parameter: the Ising coupling divided by the bath's temperature. We give its exact ground states, and single-magnon excitations. Solutions for the two-magnon spectra are derived via a Bethe ansatz scheme. In the antiferromagnetic regime, the two-magnon branch states show intricate behavior, especially regarding hybridization with the continuum. Our analysis, when combined with previous studies, suggests that the system hosts multiple dynamics at low energy. Finally, we analyze the full energy level spacing distribution as a function of the Ising coupling. We conclude that the system is non-integrable for generic parameters, or equivalently, that the corresponding non-equilibrium classical dynamics are ergodic.

Call for Nominations / Appel de mise en candidature

CJM/CMB Associate Editors

The Publications Committee of the CMS solicits nominations for Associate Editors for the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB). The appointment will be for five years beginning January 1, 2022. There are eight associate editors on the CJM/CMB Editorial Board whose mandates are ending at the end of December.

For over fifty years, the Canadian Journal of Mathematics (CJM) and the Canadian Mathematical Bulletin (CMB) have been the flagship research journals of the Society, devoted to publishing original research works of high standard. The CJM publishes longer papers with six issues per year and the CMB publishes shorter papers with four issues per year. CJM and CMB are supported by respective Editors-in-Chief and share a common Editorial Board.

Expressions of interest should include your curriculum vitae and your cover letter and sent electronically to: **cjmcmb-ednom-2021@cms.math.ca before September 15, 2021**.

Rédacteur ou rédactrice associé.e du JCM et le BCM

Le Comité des publications de la SMC sollicite des mises en candidature pour des rédacteurs et rédactrices associé.e.s pour le Journal canadien de mathématiques (JCM) et pour le Bulletin canadien de mathématiques (BCM). Le mandat sera de cinq ans et commencera le 1er janvier 2022. Il y a huite membres actuel.le.s sur le Conseil de rédaction scientifique du JCM/BCM dont le mandat se termine à la fin décembre.

Revues phares de la Société depuis plus de 50 ans, le Journal canadien de mathématiques (JCM) et le Bulletin canadien de mathématiques (BCM) présentent des travaux de recherche originaux de haute qualité. Le JCM publie des articles longs dans ses six numéros annuels, et le BCM publie des articles plus courts quatre fois l'an. Le JCM et le BCM ont chacun leur rédacteur en chef et partagent un même conseil de rédaction.

Les propositions de candidature doivent inclure votre curriculum vitae, votre lettre de présentation et doivent être envoyées par courriel électronique à : **jcmbcm-rednom-2021@smc.math.ca au plus tard le 15 septembre 2021**.

2022 CMS Research Prizes

The CMS Research Committee is inviting nominations for three prize lectureships. These prize lectureships are intended to recognize members of the Canadian mathematical community.

Coxeter-James Prize

The **Coxeter-James Prize** Lectureship recognizes young mathematicians who have made outstanding contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. Nominations may be made up to ten years from the candidate's Ph.D. A nomination can be updated and will remain active for a second year unless the original nomination is made in the tenth year from the candidate's Ph.D. The selected candidate will deliver the prize lecture at the 2022 Winter Meeting.

Jeffery Williams Prize

The **Jeffery-Williams Prize** Lectureship recognizes mathematicians who have made outstanding and sustained contributions to mathematical research. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for three years. The prize lecture will be delivered at the 2022 Summer Meeting.

Krieger-Nelson Prize

The **Krieger-Nelson Prize** Lectureship recognizes outstanding research by a female mathematician. The recipient shall be a member of the Canadian mathematical community. A nomination can be updated and will remain active for two years. The selected candidate will deliver the prize lecture at the 2022 Summer Meeting.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues for research in the mathematical sciences regardless of race, gender, ethnicity or sexual orientation. A candidate can be nominated for more than one research prize in the applicable categories; several candidates from the same institution can be nominated for the same research prize.

CMS research prizes are gender-neutral, except for the Krieger-Nelson prize, which is awarded to women only. Nominations of eligible women for the general research prizes in addition to the Krieger-Nelson Prize are strongly encouraged.

Nominations Requirements

The deadline for nominations, including at least three letters of reference, is **September 30, 2021**. Nomination letters should list the chosen referees and include a recent curriculum vitae for the nominee. Some arms-length referees are strongly encouraged. **New: the nominator most include a full citation of approximately 500 to 700 words**. Nominations and the reference letters from the chosen referees should be submitted electronically, preferably in PDF format, to the corresponding email address and **no later than September 30, 2021**:

Coxeter-James: **cjprize@cms.math.ca**
Jeffery-Williams: **jwprize@cms.math.ca**
Krieger-Nelson: **knprize@cms.math.ca**

Call for Nominations / Appel de mise en candidature

Prix de recherche de la SMC 2022

Le Comité de recherche de la SMC lance un appel de mises en candidatures pour trois de ses prix de conférence. Ces prix ont tous pour objectif de souligner l'excellence de membres de la communauté mathématique canadienne.

Prix Coxeter-James

Le **Prix Coxeter-James** rend hommage aux jeunes mathématicien.ne.s qui se sont distingué.e.s par l'excellence de leur contribution à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Les candidat.e.s sont admissibles jusqu'à dix ans après l'obtention de leur doctorat. Toute mise en candidature est modifiable et demeurera active l'année suivante, à moins que la mise en candidature originale ait été faite la 10e année suivant l'obtention du doctorat. La personne choisie prononcera sa conférence à la Réunion d'hiver de la SMC 2022.

Prix Jeffery-Williams

Le **Prix Jeffery-Williams** rend hommage aux mathématicien.ne.s ayant fait une contribution exceptionnelle et soutenue à la recherche mathématique. Cette personne doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant trois ans. La personne choisie prononcera sa conférence à la Réunion d'été de la SMC 2022.

Prix Krieger-Nelson

Le **Prix Krieger-Nelson** rend hommage aux mathématiciennes qui se sont distinguées par l'excellence de leur contribution à la recherche mathématique. La lauréate doit être membre de la communauté mathématique canadienne. Toute mise en candidature est modifiable et demeurera active pendant deux ans. La lauréate choisie prononcera sa conférence à la Réunion d'été de la SMC 2022.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs ou les directrices de département et les comités de mise en candidature à proposer des collègues exceptionnel.le.s pour la recherche dans les sciences mathématiques sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle. Une personne peut être mise en candidature pour plus d'un prix de recherche dans les catégories applicables ; plusieurs candidat.e.s d'un même institut peuvent être nommé.e.s pour le même prix de recherche.

Les prix de recherche de la SMC sont ouverts aux candidat.e.s de tous les genres, à l'exception du prix Krieger-Nelson, qui est décerné uniquement aux femmes. Les candidatures de femmes éligibles pour les prix de recherche généraux en plus du prix Krieger-Nelson sont fortement encouragées.

Conditions de la candidature

La date limite pour déposer une candidature, qui comprendra au moins trois lettres de référence, est le 30 septembre 2021. Le dossier de candidature doit comprendre le nom des personnes données à titre de référence ainsi qu'un curriculum vitae récent de candidat ou de la candidate. **Nouveau : le proposant doit inclure une citation complète d'environ 500 à 700 mots**. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, avant la date limite, à l'adresse courriel correspondante et **au plus tard le 30 septembre 2021** :

Coxeter-James: **prixcj@smc.math.ca**
Jeffery-Williams: **prixjw@smc.math.ca**
Krieger-Nelson: **prixkn@smc.math.ca**

2022 Cathleen Synge Morawetz Prize

Nominations are invited for the 2022 Cathleen Synge Morawetz Prize for an author(s) of an outstanding research publication. A series of closely related publications can be considered if they are clearly connected and focused on the same topic. The recipient(s) shall be a member of or have close ties to the Canadian mathematical community, and will receive a commemorative plaque.

The Cathleen Synge Morawetz Prize will be awarded according to the following 6-year rotation of subject areas:

1. 1. Geometry and Topology (2021, and every six years thereafter),
2. 2. Combinatorics, Discrete mathematics, Logic and foundations, and Mathematical Aspects of Computer Science (2022 , and every six years thereafter),
3. 3. Applied mathematics, including but not limited to Numerical Analysis and Scientific Computing, Control Theory and Optimization, and Applications of Mathematics in Science and Technology (2023, and every six years thereafter),
4. 4. Probability and Mathematical Physics (2024, and every six years thereafter),
5. 5. Algebra, Number theory, Algebraic geometry (2025, and every six years thereafter),
6. 6. Analysis and Dynamical systems (2026, and every six years thereafter).

All of the above fields will be understood most broadly, to ensure that any outstanding publication can be considered under at least one of the categories. A paper (or a series of papers) which has significantly impacted more than one of the listed fields can be nominated more than once in the six-year rotation. The nomination must focus on a single topic, rather than a broad body of work by the nominee.

This call for nominations is for an author(s) of a publication or a series of closely related publications in the field of Combinatorics, Discrete mathematics, Logic and foundations, and Mathematical Aspects of Computer Science.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues for research in the mathematical sciences regardless of race, gender, ethnicity or sexual orientation.

The nomination letter should highlight the research paper(s) being nominated, providing evidence of its impact and significance. The nomination letter should list the chosen referees, and should include a recent curriculum vitae of the nominee(s), if available. Up to three reference letters in support of the nomination should be sent directly to the CMS. All documents should be submitted electronically, preferably in PDF format and **no later than September 30, 2021**, to csmprize@cms.math.ca.

About the Award

The prize was established in 2020 in honour of Cathleen Synge Morawetz, to reflect the remarkable breadth and influence of her research achievements in pure and applied mathematics. Professor Morawetz completed her undergraduate studies at the University of Toronto. She was encouraged to pursue a PhD in Mathematics by Cecilia Krieger (of Krieger-Nelson Prize). She went to MIT for a master's degree, and then got her PhD at NYU, where she would spend the bulk of her career, becoming the director of Courant Institute in 1984. Her main research contributions were in the field of partial differential equations. Cathleen Synge Morawetz was a recipient of the Jeffery-Williams Prize in 1984 (the only woman to win the Prize up to date), the National Medal of Science (1998), the Leroy P. Steele Prize for Lifetime Achievement (2004) and the George David Birkhoff Prize in Applied Mathematics (2006).

Through its explicit rotation among subject areas, this prize highlights the enormous spectrum of research in the Canadian mathematical sciences community.

Prix Cathleen-Synge-Morawetz 2022

La SMC accepte les mises en candidature pour le prix Cathleen-Synge-Morawetz remis en 2022. Le prix récompense un.e ou plusieurs auteur.e.s d'un article de recherche exceptionnel ou d'une série d'articles interreliés et axés sur un même sujet. Les candidat.e.s doivent être membres de la SMC ou avoir des liens étroits avec la communauté mathématique canadienne. Les récipiendaires recevront une plaque commémorative de la part de la SMC.

Le prix Cathleen-Synge-Morawetz sera décerné en alternance à un.e ou plusieurs chercheur.e.s dans les domaines suivants :

1. La géométrie et la topologie (en 2021 et tous les six ans par la suite);
2. La combinatoire, les mathématiques discrètes, la logique et les fondements, et des aspects mathématiques de l'informatique (en 2022 et tous les six ans par la suite);
3. Les mathématiques appliquées, notamment, mais non exclusivement, l'analyse numérique et le calcul scientifique, la théorie du contrôle et l'optimisation et les applications des mathématiques en science et technologie (en 2023 et tous les six ans par la suite);
4. Les probabilités et la physique mathématique (en 2024 et tous les six ans par la suite);
5. L'algèbre, la théorie des nombres, la géométrie algébrique (en 2025 et tous les six ans par la suite);
6. L'analyse et les systèmes dynamiques (en 2026 et tous les six ans par la suite).

Les domaines susmentionnés seront compris dans leur sens le plus large pour que les articles exceptionnels puissent être considérés sous au moins l'une desdites catégories. Un article (ou une série d'articles) qui a eu un impact significatif sur plus d'un des domaines énumérés peut être nominé plusieurs fois au cours de six années de l'alternance. Le dossier de candidature doit cependant se baser sur un seul domaine plutôt que sur l'ensemble d'œuvres du et de la candidat.e.

Le premier appel à mise en candidature est destiné aux auteur.e.s d'un article ou d'une série d'articles liés au domaine de la combinatoire, les mathématiques discrètes, la logique et les fondements, et des aspects mathématiques de l'informatique.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs et les directrices de département et les comités de mise en candidature à proposer des collègues exceptionnels sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle.

Les propositions de mise en candidature doivent mettre en évidence la publication exceptionnelle, ou une série de publications exceptionnelles, sur laquelle se base la candidature tout en présentant des preuves de son impact et son importance dans le domaine. La proposition de mise en candidature doit énumérer les répondant.e.s et, si disponible, doit inclure un curriculum vitae récent du ou de la candidat.e. Jusqu'à trois lettres de recommandation à l'appui du ou de la candidat.e doivent être envoyées directement à la SMC. Veuillez faire parvenir les mises en candidature et lettres de référence par voie électronique, de préférence en format PDF, à l'adresse électronique **prixcsm@smc.math.ca** et **au plus tard le 30 septembre 2021**.

À propos du Prix

Le Prix a été créé en 2020 en l'honneur de Cathleen Synge Morawetz, afin de refléter l'étendue de son influence et de sa recherche en mathématiques pures et appliquées. La professeure Morawetz a terminé ses études de premier cycle à l'Université de Toronto. Cecilia Krieger (du prix Krieger-Nelson) l'a encouragée à poursuivre un doctorat en mathématiques. Elle a obtenu sa maîtrise du MIT et son doctorat de la NYU où elle a passé la grande partie de sa carrière et a servi comme directrice du Courant Institute en 1984. Ses principales contributions à la recherche ont été dans le domaine des équations aux dérivées partielles.

Cathleen Synge Morawetz a reçu le prix Jeffery-Williams en 1984 (à ce jour, elle est la seule femme à avoir remporté ce prix), la National Medal of Science (1998), le Prix Leroy P. Steele for Lifetime Achievement (2004) et le Prix George David Birkhoff en mathématiques appliquées (2006).

L'alternance explicite entre les matières mathématiques différentes vise à mettre en valeur un large éventail de recherches dans la communauté mathématique du Canada.

2022 David Borwein Distinguished Career Award

The Canadian Mathematical Society (CMS) invites nomination for the 2022 **David Borwein Distinguished Career Award**. This prize recognizes mathematicians who have made exceptional, broad, and continued contributions to Canadian mathematics and is awarded every four years.

The award presentation will take place at the CMS Winter Meeting in December 2022 and a plenary lecture given by the recipient.

A complete nomination dossier consists of:

- A signed nomination statement from a present or past colleague, or collaborator (no more than three pages) having direct knowledge of the nominee's contribution;
- A short curriculum vitae, no more than five pages;
- Two to four letters of support in addition to the nomination;
- Other supporting material may be submitted, no more than 10 pages.

CMS aims to promote and celebrate diversity in the broadest sense. We strongly encourage department chairs and nominating committees to put forward nominations for outstanding colleagues regardless of race, gender, ethnicity or sexual orientation.

The complete nomination and all documentation should be submitted electronically, preferably in PDF format, by **November 15, 2021**, to dbaward@cms.math.ca.

Prix David-Borwein de mathématicien.ne émérite pour l'ensemble d'une carrière

La Société mathématique du Canada (SMC) est heureux d'accepter les nominations pour le prix **David-Borwein de mathématicien.ne émérite pour l'ensemble d'une carrière** remis en 2022. Ce prix rend hommage à un.e mathématicien.ne qui a fait une contribution exceptionnelle et soutenue aux mathématiques canadiennes et est décerné à chaque quatre ans.

La présentation du prix a lieu à la Réunion d'hiver de la SMC en décembre 2022 et le ou la lauréat.e prononcera une conférence à la réunion.

Le dossier de candidature comprendra les éléments suivants :

- une lettre de mise en candidature signée par un.e collègue ou un collaborateur ou une collaboratrice actuel ou des années passées (trois pages maximum) qui connaît très bien les réalisations de la personne proposée;
- un bref curriculum vitae, maximum de cinq pages;
- de deux à quatre lettres d'appui, en plus de la mise en candidature;
- tout autre document pertinent, maximum de 10 pages.

La SMC a pour but de promouvoir et de célébrer la diversité au sens le plus large. Nous encourageons fortement les directeurs et les directrices de département et les comités de mise en candidature à proposer des collègues exceptionnel.le.s sans distinction de race, de genre, d'appartenance ethnique ou d'orientation sexuelle.

Veuillez faire parvenir le dossier complet et tous les documents par voie électronique, de préférence en format PDF, **au plus tard le 15 novembre 2021** à prixdb@smc.math.ca.